The AMSAT Journal

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RS-15 Satellite Launched

Last December 26 the newest satellite carrying amateur radio was launched from the Baykonur Space Center in Russia. Known as RS-15, this satellite is spherical in shape, about one meter in diameter and weighs approximately 70 kg. On board there is a transponder, two radio beacons, a CW broadcast bulletin board, a remote control system and a telemetry system. The satellite has no orientation or stabilization systems. All of the on-board electronics were designed and constructed by a group of radio amateurs from Kaluga under the leadership of Aleksander Papkov. The control station, located in Moscow, is the same as for RS-10/11 and RS-12/13, and is headed by Leonid Maksakov.

The uplink passband from RS-15 is 145.858 to 145.898 MHz, requiring approximately 100 watts IERP. The downlink can be heard on 29.354 to 29.394 MHz with a beacon on 29.352.5 Mhz. Reception reports should be sent to the control station, RS3A at P.O. Box 59, Moscow, Russia 105122 or via internet to rsgroup@olymp.msk.su.

Early Reports on RS-15

by Bob De Varney, WE1U

My personal experience with RS-15 has been good. At first, shortly after launch, it appeared to be spinning fairly rapidly, and the resulting spin modulation made contacts a bit dicey. After a week or so, things seemed to stabilize a bit and now it is a great bird to work. The transponder is not quite as loud as the other birds, but being only 70 kg. total compared to the 1000 or so kg. of RS-10 and RS-12, this is understandable. From the passes I have seen, it appears to do an east-to-west pass, instead of a north-to-south pass as most others do. It also appears to have a larger footprint than the other RS birds. A typical pass went something like this: N8LGP; N0ZHE, Kansas; VE8CF, Northwest Territories; VE6LU, Alberta; WB6LLO, California. The next pass resulted in a QSO with K5MEI in Baton Rouge. I have not been able to work any passes in the past 3 weeks or so due

Continued on Page 4

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Apogee View

Upcoming Opportunities to Get Together

by Bill Tynan, W3XO

One of the fun things about Amateur Radio in general and amateur satellites in particular is the camaraderie it affords us. Of course, there is the ever present opportunity of getting together on the air. But, particularly during the next six months, is the chance to meet each other in person at the various upcoming hamfests, conventions and other meetings.

The "grand daddy" of all is the Dayton Hamvention, to be held April 28 through 30. AMSAT will be there in force again this year. We will have a large booth in the usual spot (Booths 445 -448). There will also be two AMSAT forums, one Friday Afternoon from 1:00 to 3:00 PM and the other at the same time on Saturday. One of these forums will be devoted to the operating phase of the amateur space program, primarily featuring material for those just now contemplating diving into the fascinating world of satellite operation, and those who have only recently done so. This forum will also cover some of the more advanced aspects of this facet of our hobby, such as using the digital birds and Mode S operation. The other forum will concentrate on bringing attendees up to date on the latest developments and near-term prospects for SAREX and Phase 3D. Dayton affords many hams their best opportunity to update themselves on the latest in Amateur Radio, including satellites, pick up new and not-so-new gear; and best of all, meet new and old friends. We'll be looking forward to seeing many AMSAT members and signing up a lot of new ones.

The same goes for many other amateur gatherings to be held over the next few months. Notable among these is Hamcomm to be held June 9 through 11 in Arlington, Texas, between Dallas and Fort Worth. Although not as large as Dayton, Hamcomm is, nevertheless, a large affair, with an attendance of ten thousand or more. AMSAT will, again this year, put a major effort into Hamcomm with a well-located booth and forum material on a par with that presented at Dayton.

In addition to Dayton and Hamcomm, there will be many other smaller hamfests held in many parts of the country over the spring and summer months, which will feature AMSAT booths and forums staffed by dedicated and knowledgeable volunteers. Attendance at one or more of these get-togethers is certain to be a source of education and enjoyment.

Speaking of meetings, the AMSAT Annual Meeting and Space Symposium always represents the ultimate chance to spend a couple of days totally immersed in all aspects of amateur satellites. From the always informative technical presentations to the informal conversations in the corridors with other OSCAR devotees, this affair is the high spot of the year for many AMSAT members old and new. Last year's meeting was held in at the Airport Holiday Inn in Orlando, Florida. This site was selected primarily to provide attendees the opportunity to visit the nearby AMSAT Spacecraft Integration Facility and view the Phase 3D satellite which had recently arrived from Weber State University in Utah.

The search for a suitable site for this year's meeting was begun as the 1994 gathering was still in progress. In the ensuing weeks, several locations were considered and pursued, including the possibility of Tucson, or Phoenix, Arizona. A critical factor in selecting a site for a meeting such as ours is the availability of a willing group of people to handle the arrangements. There is such a group in those cities and a desire to hold the meeting somewhere in the West, in order to draw people from that part of the country who might feel that they could not make the trip to the East Coast. Recall that the 1993 meeting was held in Washington, DC and 1992's in Arlington, Texas. It has not been since 1991 that we met in the West, when Los Angeles was the site.

The bottom line is that, despite the hard work of a number of individuals, we were

not able to conclude suitable arrangements in either Tucson or Phoenix in time for this year's meeting. And, since we had such a good relationship with the particular hotel, we have decided to return to that same location for 1995.

Many of the same people who put on last year's meeting will be involved again this year, but a few others will step in as well. So, the AMSAT Annual Meeting will be held at the Orlando Airport Holiday Inn October 6th, 7th and 8th. It is impossible to know at this time whether or not the Phase 3D satellite will still be at the facility; but attendees can be sure that, if it is, they will have the opportunity to again tour the facility and view it. By then, the flight modules and other equipment will definitely be in place. We hope to see many members, and others interested in amateur satellites, in Orlando next October.

It has been decided that the 1996 meeting will definitely be held in Tucson. There is the prospect of one or more very interesting side trips, and hotel arrangements are now in the process of being finalized. See you in Tucson in the fall of 1996.

Early Reports on RS-15

Continued from Page 1

to a crazy schedule at work, but I would suspect that Europe should be pretty easy to work as well.

A lot of thanks and kudos should go to N2WWD for his hard work establishing a working set of keps for RS-15. I am sure he has put in quite a bit of work on this, and should be commended for it. He was able to "tweak" the elements, and come up with sets that were far more accurate than those provided by NASA until just recently. Lastly, I think we should thank and commend the team who built and launched RS-15 for another great RS bird. As usual, a job well done!

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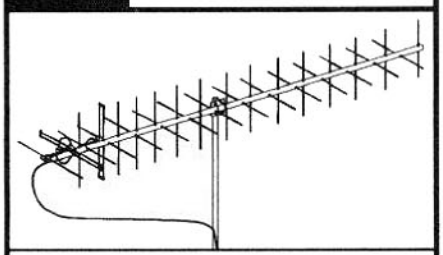

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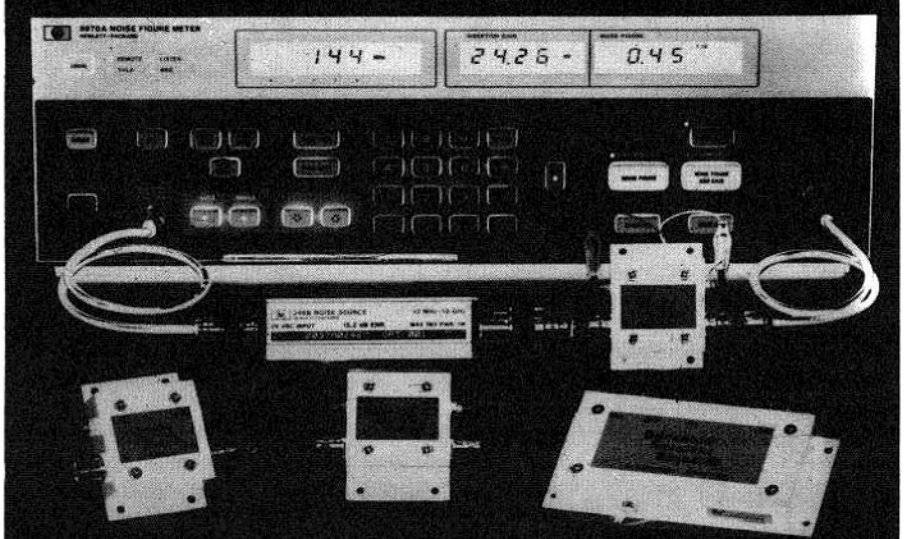

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SP50VDG	50-54	<0.55	24	+12	GaAsFET	$109.95
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SP144VDG	144-148	<0.55	24	+12	GaAsFET	$109.95
SP220VD	220-225	<1.9	15	0	DGFET	$59.95
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SP220VDG	220-225	<0.55	20	+12	GaAsFET	$109.95
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AMSAT on the World Wide Web

Paul Williamson, KB5MU

AMSAT VP for Electronic Communications

email: kb5mu@amsat.org

AMSAT has begun to use a new communications mode. No, its not a new transponder or yet another modulation type for digital downlinks. This mode is used for communicating with interested non-amateurs and amateurs not yet involved in satellite communications, as well as among ourselves in the AMSAT community. Its called the World Wide Web, and it serves as a combination storefront, newsletter, and reference library, available continuously via the Internet.

The Internet

The Internet is a huge world-wide network of interconnected computers. At most universities and high-tech companies, and at an increasing number of other companies and government agencies, virtually every computer is on the Internet, from the big corporate mainframe down to a lowly PC on a desktop. Large computers are usually connected to the Net all the time, with a reliable high speed connection capable of transferring from 56,000 to 100,000,000 or more bits per second. Small computers may be connected continuously on a high-speed local area network, or they may only connect occasionally through a relatively slow dialup telephone connection using a modem.

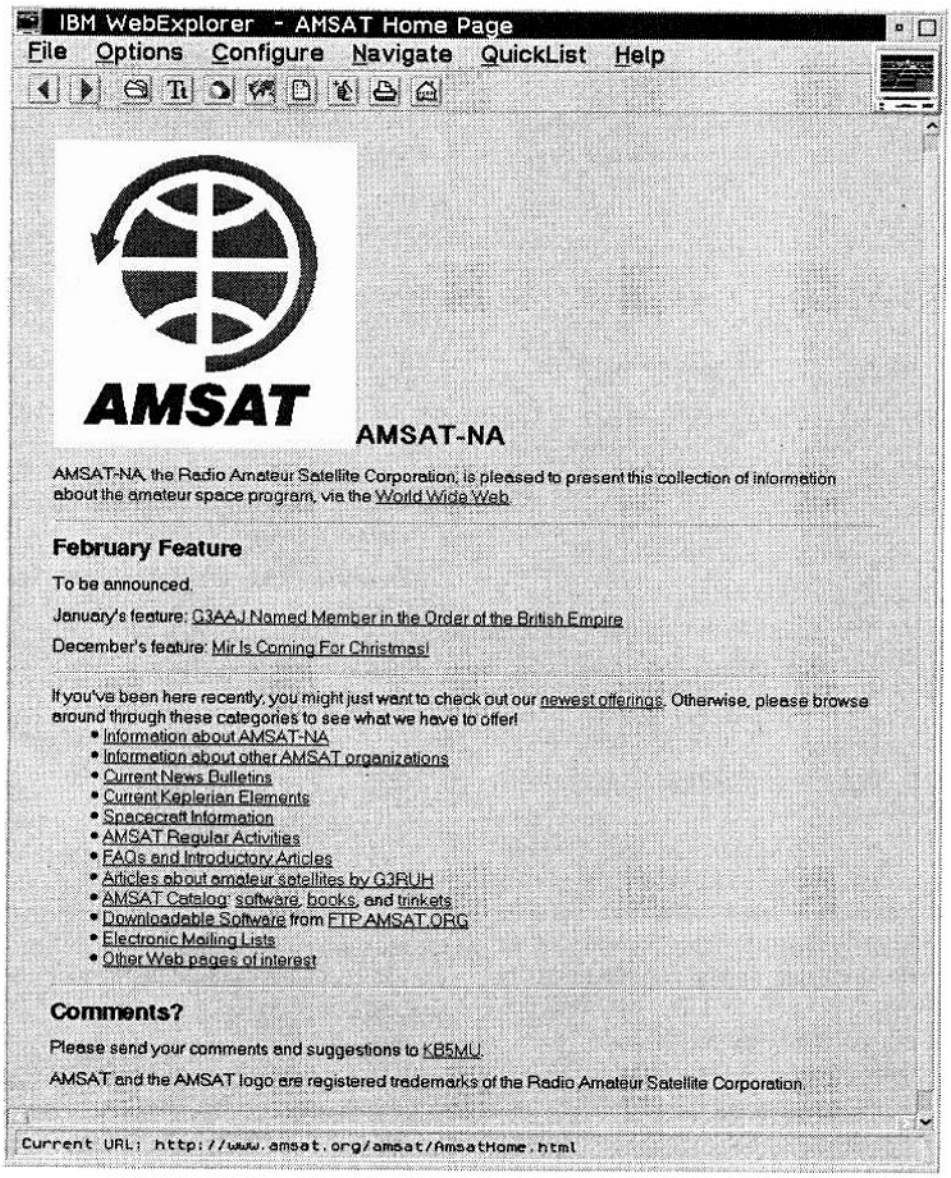


Figure 1

Regardless of how they are connected, all the computers on the Internet share a common set of protocols for exchanging information. (You've probably heard of it: its called TCP/IP. This article isn't about TCP/IP. If you want to learn more about it, see references [1,2] and many other books and articles).

Electronic Mail

Probably the most popular and widespread use of the Internet is for electronic mail. Many computers that are not actually on the Internet are able to exchange electronic mail with each other and with computers on the Internet. Commercial services like CompuServe, America On-Line, Delphi, and many others provide a way to send email to and receive email from users on the Internet. AMSAT makes extensive use of electronic mail. Much of the coordination between far-flung groups of AMSAT volunteers working on AMSAT projects happens via email. AMSAT maintains a computer on the Internet, named AMSAT.ORG, which handles distribution of email to groups of recipients. There are presently five public mailing lists available from AMSAT.ORG:

ANS -- AMSAT News Service bulletins

KEPS -- Keplerian Elements bulletins

AMSAT-BB -- an open discussion forum

SAREX -- bulletins about the Space Shuttle Amateur Radio Experiment

NASAINFO -- other information released by NASA

If you have access to Internet email, you can receive any or all of these mailing lists. For detailed information, send an email message to the Internet address *listserv@amsat.org* requesting help. In addition, there are quite a few private email lists for various projects and working groups within AMSAT. If you are working on an AMSAT project that could make use of a mailing list, send mail to *kb5mu@amsat.org* describing what you need.

File Archives

Another popular and important resource offered by the Internet is a means for retrieving publicly available files from another computer (a server) on the Net. This is usually called *anonymous FTP*. FTP is just the name of the protocol used to retrieve

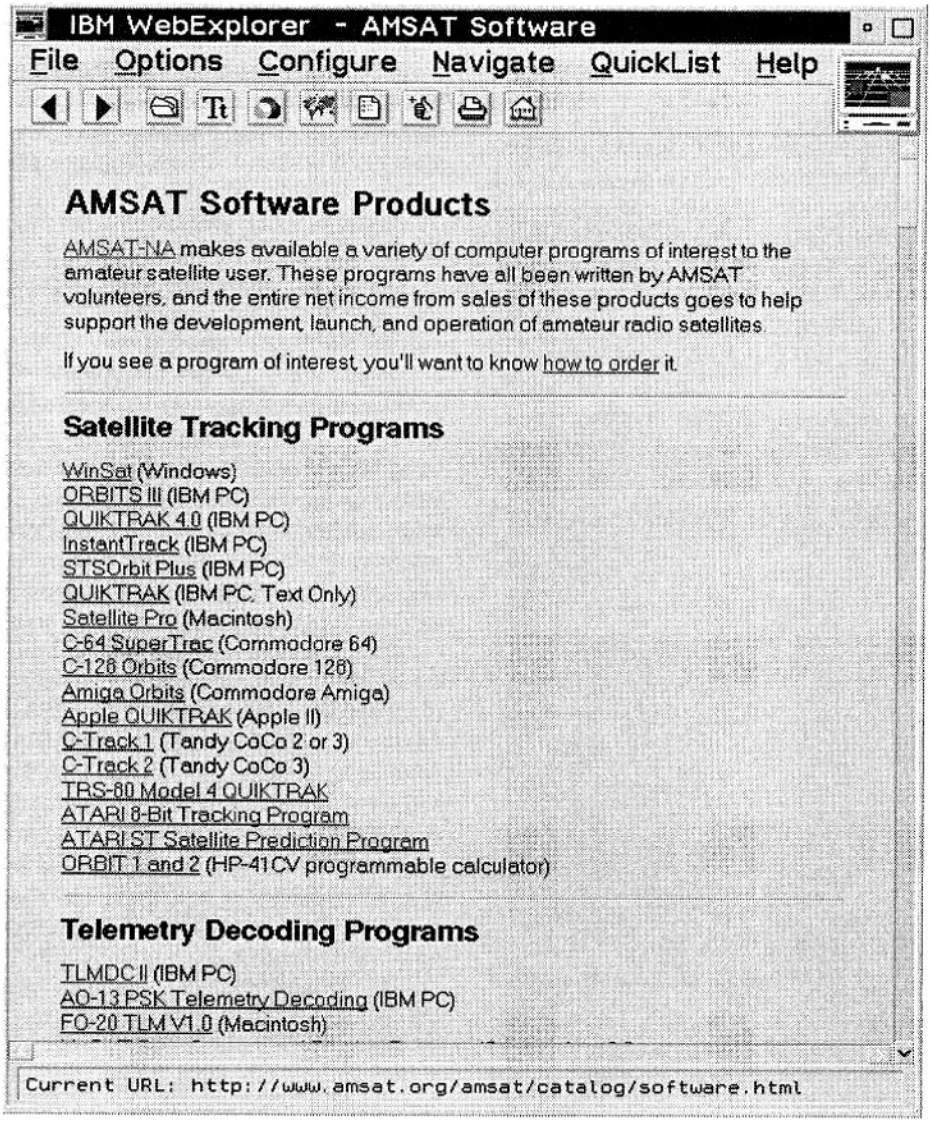


Figure 2

files: File Transfer Protocol. Its called anonymous because you don't have to be anybody in particular to retrieve the files: instead of logging on to the server with an authorized user name, you use the dummy user name *anonymous*.

FTP is not the easiest procedure in the world. First, the user has to know the name of the server, say *oak.oakland.edu*, that might have the file he wants. The user starts an FTP program on his own computer, typically by typing something like *ftp oak.oakland.edu*. At the *Username*: prompt, the user enters *anonymous*. At the *Password*: prompt, the user enters his real email address. Then the user sees the ftp> prompt, and has to navigate through the directory hierarchy on the server using the *dir* (get directory listing) and *cd* (change directory) commands, until he finds a file of interest. Then, if the file is not plain text, he has to enter *binary* to set binary transfer mode. Then he can finally enter *get filename* to retrieve the file to his own computer. As you can see, the procedure is a bit of a pain. Some computers have fancier FTP programs that make this procedure easier, but all the basic steps are still required.

AMSAT now maintains an FTP server with lots of files related to the amateur radio space program. The host name is FTP.AMSAT.ORG. Here are some of the things available to one and all from this server:

Current Keplerian Elements

AMSAT News Service bulletins, including back issues

SpaceNews by John Magliacane, KD2BD, including back issues

A wide variety of software for IBM PC under DOS and Windows, Macintosh, Linux, Unix, and other environments, including satellite tracking programs, telemetry analysis tools, Pacsat groundstation software, and lots more. Many of these programs are free. A few require a shareware payment to the author or to AMSAT.

A growing collection of articles published by James Miller, G3RUH, covering many aspects of amateur satellite operation.

A small but growing collection of files full of information about various amateur spacecraft and how to use them.

Information on the mailing lists offered by AMSAT.ORG.

Remember, the name of the FTP server is FTP.AMSAT.ORG, not just AMSAT.ORG. Also, be sure to set *binary* mode before you transfer non-text files like programs or .ZIP archive files. All the files are to be found under the /amsat directory.

For many years, Internet users have used anonymous FTP as a way of storing reference materials. For example, if a group of users develops a list of common questions and answers in a particular field, that document (called a FAQ, for Frequently Asked Questions) might be made available to all by placing it on an FTP server and announcing the name of the server to the group. This way, any member of the group can always obtain the latest version of the FAQ at any time. Provided, of course, that he remembers the name of the server.

Something better is clearly needed. The most ambitious of these schemes, and the one that seems to be a runaway success, is called the World Wide Web, or WWW, or W3, or just the Web.

The World Wide Web

The World Wide Web project was started at the European Laboratory for Particle Physics, CERN. They describe it as the universe of network-accessible information, an embodiment of human knowledge. Techniques called *hypertext* and *multimedia* are combined to make the Web easy to use and contribute to.

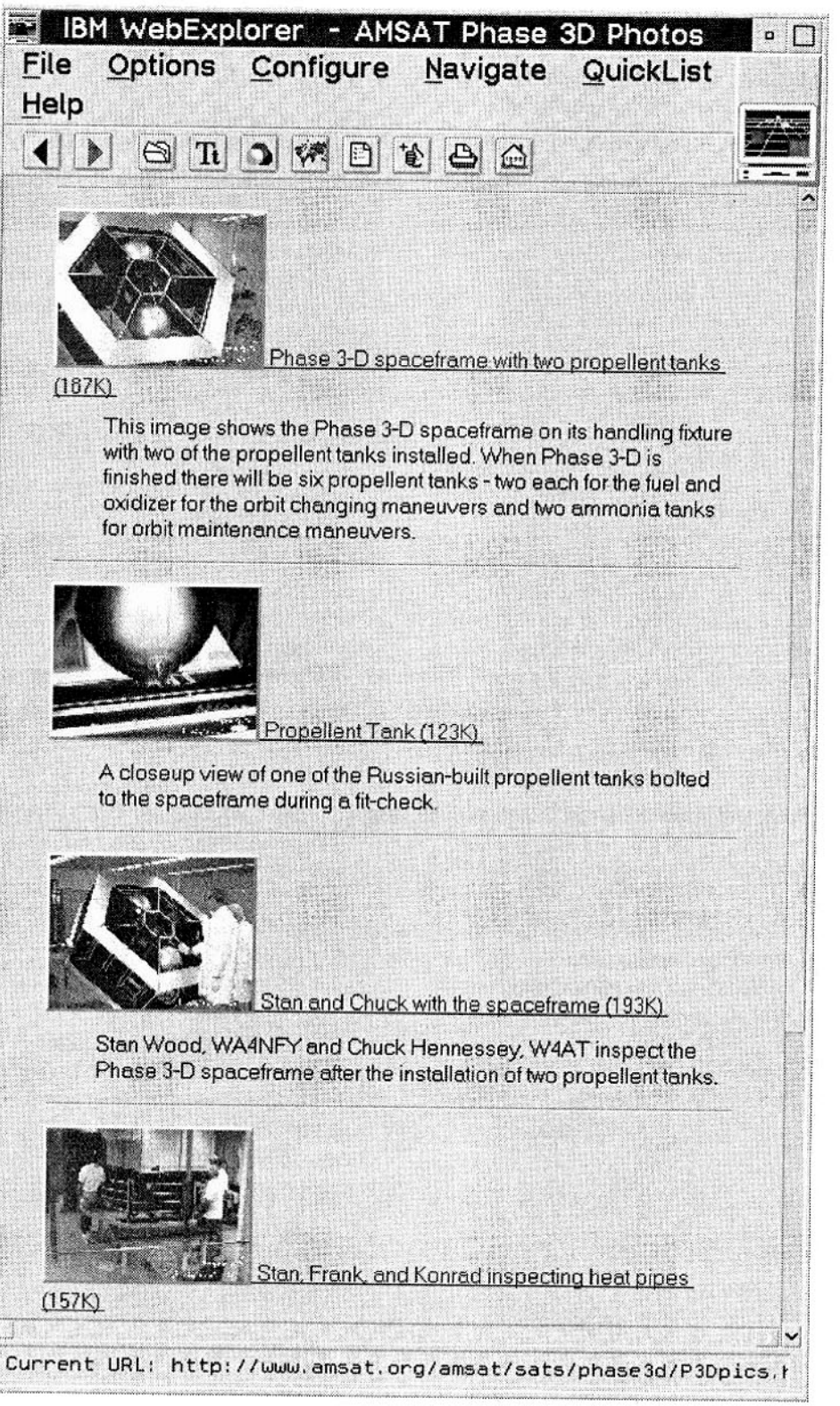
Information on the Web is contained in documents called *pages*. A Web page can contain virtually anything, but most pages are basically text. The text is stored in a special format called HTML, for Hypertext Markup Language. This format is some-

what like a word-processor format, in that it can express headings, italics, bold text, itemized lists, and many other constructs seen on the printed page that go beyond plain text. Like a modern word-processor, HTML can even include photographs and diagrams in line with the text.

The most important feature of HTML is that it can include *links* to other objects. A user selects a link to access an object. The object can be on the same server, or it can be on any other server anywhere on the Internet. The object can be another Web page, or it can be an image file, or a sound file, or a movie file, or almost anything else. All the information needed to access the object is included in the link. All the user has to do is select the link, most commonly by clicking on it with a mouse. There is nothing to remember, and no extra hassle if the desired object is on a different computer.

The idea that text can contain links to other places in the text, instead of just being presented in a predetermined order, is called hypertext. This powerful idea has been around for quite a while, but the World Wide Web is the first practical large-scale application. Imagine how neat this can be when all the right links are in place. Here in the Journal, I can provide a reference to information on early thoughts on hypertext [4], or I can define multimedia in a footnote, but on the Web I can provide links that give you easy access to whole volumes of information on those subjects. Other authors will, in turn, provide links to my works, where appropriate, so you will always have access to more information.

These features allow the user to access selected parts of a large body of information in any order he chooses. The Web goes beyond that, to provide means for the user to access information that is customized to his needs. A Web page can include an on-screen *form* to be filled out by the user. The user enters whatever information is requested by the form, and that information is sent to the specified Web server. The server interprets the responses, and formulates a custom Web page for the user. For example, a callsign server could ask you to enter a callsign, and then return the name and address information from the FCCs database. Or, an ephemeris server could ask you for your location and the name of a satellite, and return a table of upcoming passes over your station, with azimuth and elevation information computed just for you. Both of these services are available today on the Web.



Web Browsers

The program you run on your computer to access the World Wide Web is called a Web browser. Browsers are available for most popular computers, mostly for free. The original Web browser is Mosaic, from the National Center for Supercomputing Applications (NCSA). Mosaic is available for Microsoft Windows, the Macintosh, and Unix workstations running the X Window System. You will sometimes hear people

Multimedia refers to the seamless integration of various forms of expression, such as text, audio, images, and video.

say Mosaic when they really mean any Web browser program. In Mosaic, most operations are performed with the mouse. To select a link, you just click on it.

Lynx is a Web browser for text only. It is designed to run on a mainframe or minicomputer with users connected via plain text terminals without graphics or sound capabilities. Of course, these users wont be able to see the inline images, but the hypertext itself is still accessible. Lynx uses the cursor keys and the main keyboard to navigate through the Web pages and select links.

Other programs are now starting to appear to compete with Mosaic. For Windows users, a Mosaic spinoff called Netscape is quite popular. Netscape is quite similar to Mosaic, but supports a variety of new extensions to HTML. Some of these extensions will be standardized for inclusion in all browsers, and others will be abandoned, but Netscape gives users a chance to experiment with the latest features. The Netscape browser is free; the company sells a commercial version of server software that supports these experimental features.

Some computers not supported by Mosaic are supported by other browser programs. I use a native OS/2 program from IBM called WebExplorer. This program comes free with the latest version of OS/2. Rumor has it that Microsoft will be releasing a Web browser of its own, as part of a new network venture. This is a rapidly-evolving field; by the time you read this, there will probably be other programs available.

To get started, you need a computer that can be connected to the Internet. That might be your workstation on the LAN at work, or you can use a modem to dial in to an Internet provider from home. There are many options for getting connected to the Internet. These options are beyond the scope of this article, but you'll find that the computer section of your local bookstore is overflowing with books on the Internet, for all experience levels. Choose one that seems appropriate to you, or consult your local computer guru for guidance on how best to get connected to the Internet.

AMSAT on the Web

AMSAT now has a Web server on the Internet. The Web is a peculiar form of publication, and can serve AMSAT in a number of different ways.

The AMSAT Web pages serve as AMSATs front door to the people of the Internet. The Internet is full of people who are generally interested in technical things, or at least not too intimidated by them. These people are prime candidates for recruiting into amateur radio in general and AMSAT in particular. To them, the AMSAT Web pages are like a glossy brochure. They can quickly learn what AMSAT is about, and perhaps become interested enough to wish to learn more.

To the general amateur radio community, AMSATs Web pages are like an introductory article on how to get started in amateur satellites, or like the AMSAT

Continued on Page 18

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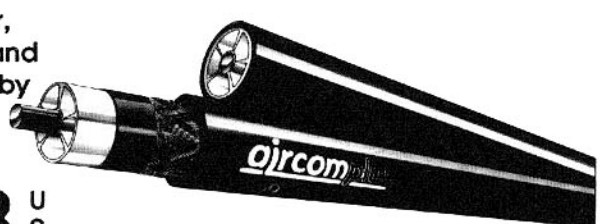

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SSTV on Amateur Radio Satellites

by Dave Guimont, WB6LLO

While Slow Scan Television (SSTV) has been successfully used on HF for decades, use of this mode via amateur satellites is much more recent. Encouraged by N5BF, Courtney Duncan, SSTV experiments began on OSCAR 13 early in 1991 following successful SSTV operations with the space shuttle. At the time Courtney was the AMSAT Operations Officer and the AMSAT Operations Net manager. Sporadic SSTV activity had taken place on Oscar 13, but this is the first known activity to attempt to document results. The effects of Doppler, polarity changes, antenna pointing angles and signal strength variations were yet to be explored.

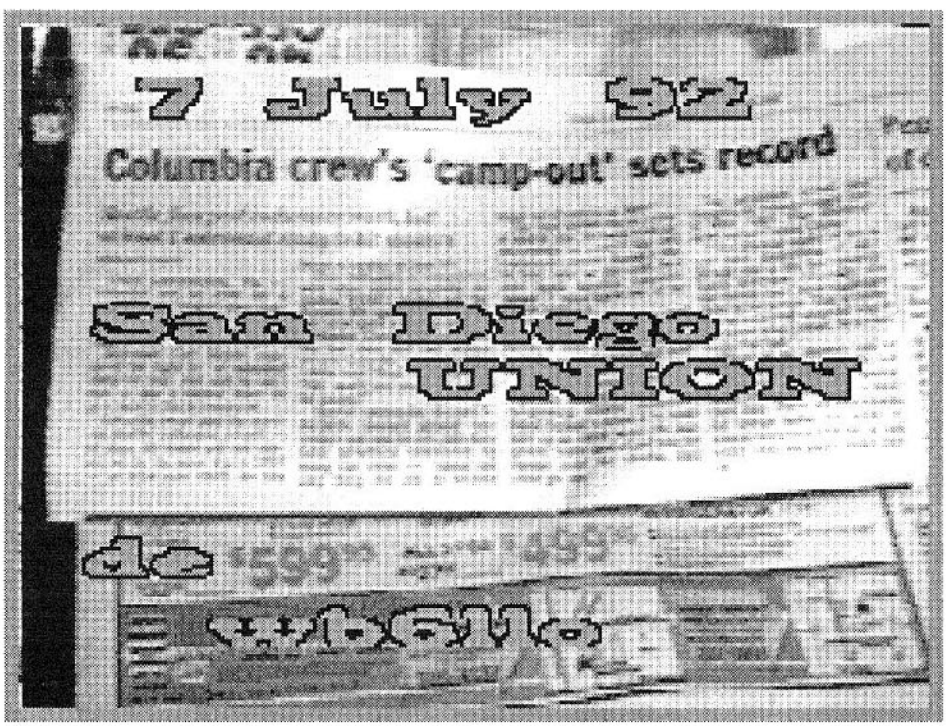


Figure 1

Scheduling proved to be one of the problems. Those of you familiar with satellite operations and have attempted schedules on AO-13 know that one can keep about a third of the world happy with whatever sked is decided upon!

The second consideration was Doppler. OSCAR 13 is in a high elliptical orbit. The Doppler is maximum at perigee, minimum at apogee. Though the transmission distance is reduced at perigee the use of omni directional antennas results in reduced signal strengths. At perigee, transmission of a single picture could require over 72 seconds. This, in turn, might require a frequency adjustment in the middle of the picture, with a resulting loss in picture quality.

Antenna pointing angles are a result of adjusting the spacecraft's attitude to provide maximum solar illumination for the panels commensurate with optimum antenna orientation. This operation is ably performed by the team of G3RUH, DB2OS and VK5AGR. Satellite antenna pointing angles for various Mean Anomoly values (which indicate the position of the satellite in its orbit) are published well in advance by G3RUH. Experienced satellite users can easily determine and predict with certainty world wide picture transmission potentials.

Because the number of OSCAR 13 SSTV users is still a relatively small (but growing) minority, it has been found that scheduling SSTV nets provides the best results. SSTV net operations are currently conducted on Saturdays and Sundays on a downlink frequency of 145.955 (mode B). The net meets both days 45 minutes before the transition to mode S, and again on mode B immediately after mode S. These times will, of course, vary from week to week, but will provide the best signals for that particular orbit.

WB6LLO in San Diego will act as liaison for schedules at other times if desired. He is available on KO23, KO25, the AMSAT OPSNETS and Internet, wb6llo@amsat.org; or reasonable hour phone calls ..... (619)275-1495.

Operation is simplicity in itself. Audio lines are connected depending on the particular mode. You are monitoring your own

Figure 2

downlink and assuming similar receiving conditions at the other station, one can quite accurately predict picture potential. Under good conditions it is very easy to tape record your own transmission, and replay it to your own equipment with very little loss in picture quality. The fact that the signal has traveled about 50,000 miles round trip and being relayed by just a few watts of power at the satellite end adds to fun of using this mode.

Because of Doppler, the receive frequency needs constant attention. The accepted satellite procedure is for the sending station to say a few words on ssb just prior to picture transmission. This enables the receiving station to tune accurately, and no subsequent adjustment is generally required. Picture quality is directly dependent on signal strength and signal to noise ratio. Nothing new here, but all prudent satellite users keep their downlink signal at beacon level. The slightest co-channel splatter deteriorates quality.

Several hundred users worldwide have expressed an interest in slow scan on the satellites. In the authors experience fifty or so of those stations have engaged in picture exchanges. All picture displays are full color originals. The transition to black and white results in some degrading of quality.

The space shuttle STS-50 had Robot slow scan equipment on board and many pictures were exchanged with ground stations. The crew on STS-50 set a record in space. The San Diego Union reported that fact in the morning paper and WB6LLO re-

Figure 3

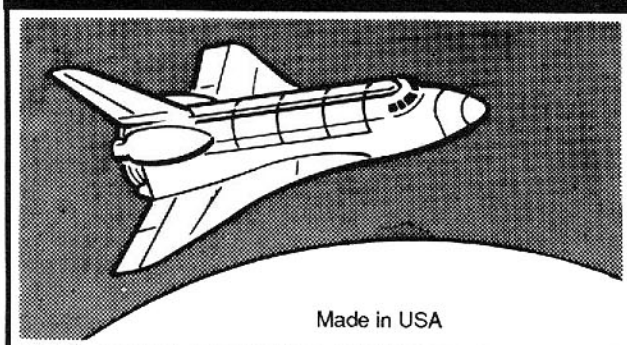
layed a picture of that article, to the shuttle in what was probably the first newspaper delivery in space, Fig. 1! All SSTVer's do the instant QSL routine, and that was also accomplished with STS-50.

WB6LLO taped his "AO13 CQ", and the downlink picture, Fig. 2, indicates picture quality potential. The original is full color, and the transition to black and white for publication in this Journal causes some degrading.

It is a real pleasure to be able to "see" the person you are in communication with. We would all certainly recognize each other should a convention meeting take place! Figures 3, showing Hans, OE1HAB proves the point!

If you are not satellite equipped, perhaps there is a satellite operator in your area with whom you could combine operations. *The Satellite Experimenter's Handbook* available from ARRL is must reading for all satellite operators. AMSAT headquarters at 850 Sligo Avenue Silver Spring, MD 20910-4704, telephone (301) 589-6062 is an information source. Become a member and help support the amateur satellite program and receive as a bonus six issues of The AMSAT Journal and discounts on the software they have available.

AMATEUR TELEVISION



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SSTV on the Cheap

by John Hansen, WAØPTV

What, you may ask is Hansen doing on SSTV? Well, I'm not really sure, except to say that it's interesting, and it's cheap. Good enough for me. I first became interested in SSTV at Dayton last spring. I didn't intend to go to the SSTV forum, but Dayton was very crowded, I was quite tired and not altogether well, so I did what I always do under these circumstances; I went to the nearest forum to find a seat. In this case it happened to be a forum on Slow Scan Television (SSTV). For those of you who have not experienced SSTV, it is a technique for transmitting pictures over narrow (2.5 kHz) radio channels. To hear what it sounds like, tune to 14.230 MHz almost any time the band is open and listen to the signals.

Anyway, John, WB2WXN and I dropped into the SSTV forum. I found it to be fascinating... particularly the presentation concerning the use of SSTV in the 1930s. One of the most interesting things about the forum was and advertising flyer that I found on the floor for a guy in the flea market who was selling SSTV systems (implemented in software) for just over $20. I wondered if this was for real... after all SSTV systems used to cost upwards of $1000. John and I spent the rest of the weekend looking for this guy in the flea market, but the weather was so bad that virtually everyone outside had gone home. Just as well. Since then I've learned that $20 was OVERPRICED!

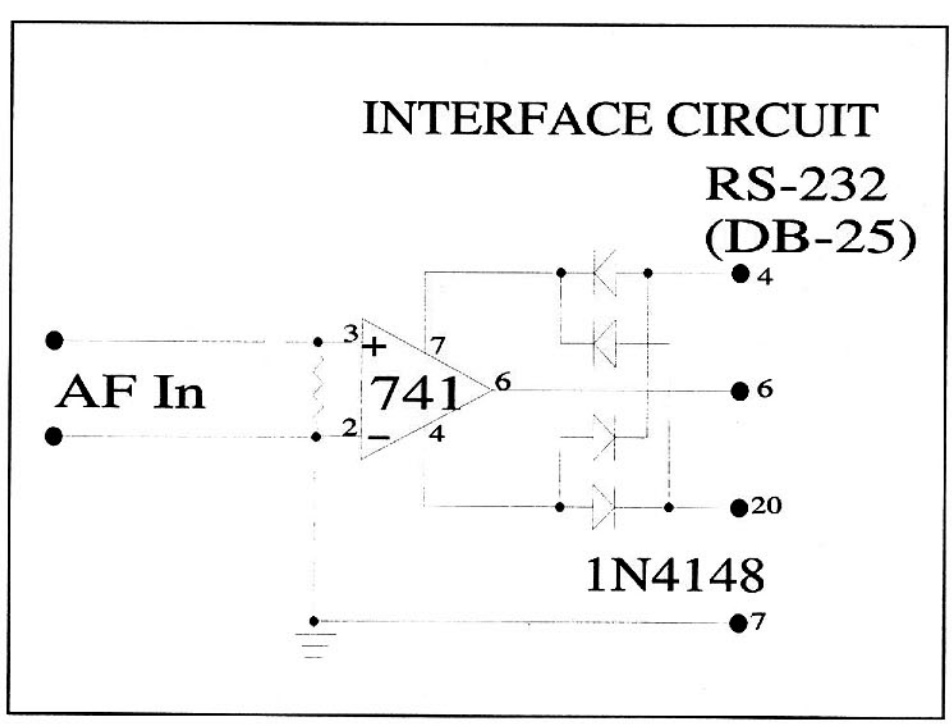
If you want to get involved in SSTV , take the following parts list down to your local Radio Shack:

Item	Part #	Price
.1 mfd disc cap	272-136	.69 (for 2)
47K ohm resistor	271-????	.49 (for 5)
1N4148 diode	276-1122	1.19 (for 10, you need 4)
741 op amp	276-007	.79
8 pin IC socket	276-1995	.69 (for 2, optional)
dual IC board	276-159	1.69 (split it in half)
TOTAL COST		5.44

Better yet, find a friend and buy a second 741 op amp. Then you will have enough parts to build two of these things for $6.19. Even after allowing for sales tax you should be able to build these things for about $3.50 each. Now you will need some connecting wire to hook it both to the audio line from your radio and to the serial port on your computer. You will also need appropriate plugs for your radio and computer. But that's all there is to it. The attached figure shows the circuit diagram you will need to follow to build the unit. Pay close attention to the polarity of the diodes. It won't work if you install them backwards. The line on the diode itself corresponds to the side of the diode in the circuit diagram that has the line on it. I routinely use sockets for all IC's I use, though in this case the socket is almost as expensive as the IC. You can use a socket or not as you prefer. Hold the IC rightside up with the notch on top. The pins down the left side will be numbered 1, 2, 3, 4. The pins down the other side will be number 8, 7, 6, 5. Thus, pin 1 is directly across from pin 8. You will have to do some planning to get the layout working on the Radio Shack circuit board, but there's plenty of room here for a relatively uncluttered layout. My first effort included some jumper wires, I'm hoping to have a neater design the second time around.

The next step is to obtain the JVFAX software. This available on many bbs's, and on various Internet sites. This software runs on MS-DOS computers and will require at least an 80286 processor and preferably an 80386 processor. It installs fairly easily and is well documented. In addition to doing SSTV, it will also receive FAX transmissions. The latest version is 7.0.

Unfortunately, as I have rushed this article to press, I am writing it before I have had a chance to put my SSTV system through its paces. I do have it connected to the radio and computer and have been able to determine that the computer is receiving data through the device. However, I've only attempted to receive one picture so far and it doesn't look like much. I think this is a software problem (I've not actually read the documentation yet) and I hope to have it corrected soon. Build one yourself and hop on AO-13.



Phase 3D Bandplan

P3D UPLINK BANDPLAN

IF	Digital	Analog
		10.720 - 10.680 MHz
15m	none	21.210 - 21.250

IF	Digital 10.815 - 10.775 MHz	Analog 10.775 - 10.625 MHz
2m	145.800 - 145.840	145.840 - 145.990

IF	Digital 11.075 - 10.825 MHz	Analog 10.825 - 10.575 MHz
70cm	435.300 - 435.550	435.550 - 435.800
23cm(1)	1269.000 - 1269.250	1269.250 - 1269.500
23cm(2)	1268.075 - 1268.325	1268.325 - 1268.575
13cm(1)	2400.100 - 2400.350	2400.350 - 2400.600
13cm(2)	2446.200 - 2446.450	2446.450 - 2446.700
6cm	5668.300 - 5668.550	5668.550 - 5668.800

P3D DOWNLINK BANDPLAN

IF	Digital 10.775 - 10.815 MHz	Analog 10.625 - 10.775 MHz
10m	29.330 +/- 5 kHz	
2m	145.955 - 145.990	145.805 - 145.955

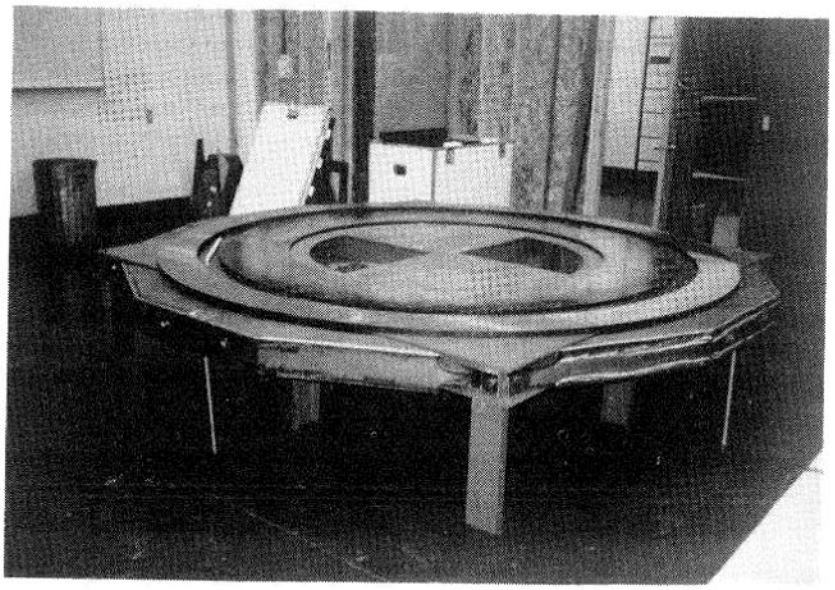
IF	Digital 11.000 - 11.300 MHz	Analog 10.575 - 10.825 MHz
70cm	435.900 - 436.200	435.475 - 435.725
13cm	2400.650 - 2400.950	2400.225 - 2400.475
3cm	10451.450 - 10451.750	10451.025 - 10451.275
1.5cm	24048.450 - 24048.750	24048.025 - 24048.275

IF	Beacon-1 10.55 MHz	Beacon-2 10.95 MHz
2m	none	none
70cm	435.45	435.85
13cm	2400.2	2400.6
3cm	10451	10451.4
1.5cm	24048	24048.4

Notes:

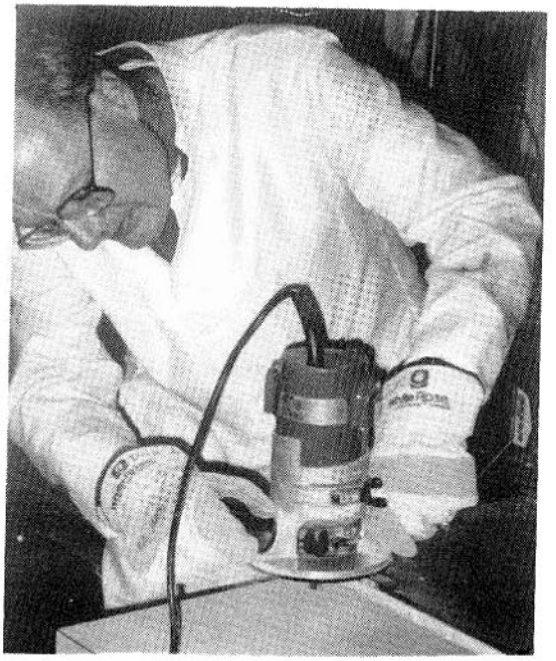
1. Receivers are inverting.
2. The analog transponder passband is from -125 kHz to +125 kHz about the 10.7 MHz IF.
3. The digital transponder passband is from +125 kHz to +375 kHz relative to 10.7 MHz.
4. The bandwidth on 2m is smaller. There is an additional bandlimiting filter in the transmitter. Otherwise we would have out-of-band transmissions, including both beacons. Hence there are no beacons on 2m.
5. Both beacons are generated separately at 10.7 MHz and are no longer part of the exciter(s) / transmitter(s).
6. Beacon-1 is the old General Beacon and Beacon-2 is the old Engineering Beacon.
7. Rudak extensions for downlinks are available from 10.850 - 11.000 MHz giving an additional 150 kHz if Beacon-2 is OFF.
8. An additional 200 kHz (500 kHz) is available from 11.3 - 11.5 MHz (11.8 MHz) is the TX has enough BW.

Information supplied by DB2OS



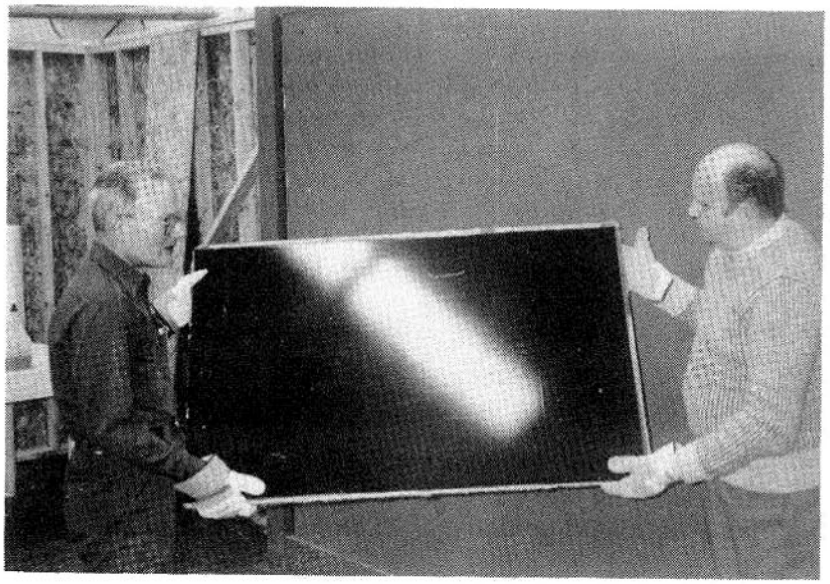
The Phase 3-D structural assembly table in the Phase 3-D laboratory at Weber State University, Ogden, Utah. The table was used to assemble the flight model Phase 3-D spacecraft structure, and is currently being modified by Weber students who will then use it to construct P3-D's cylindrical carrying structure, called the SBS. The SBS will house Phase 3-D on the Ariane 5 upper stage as it rides to orbit.

(AMSAT-NA photo by Keith Baker, KB1SF)



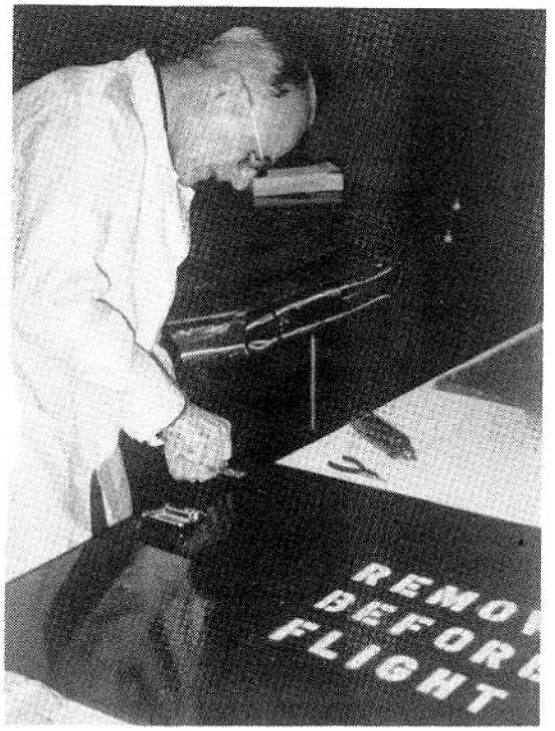
Dick Jansson, WD4FAB, uses a router to "square up" the sealed Epoxy edges of a Phase 3-D flight model solar panel in the Phase 3-D laboratory at Weber State University, Ogden, Utah.

(AMSAT-NA Photo by Keith Baker, KB1SF)



AMSAT-NA VP, Engineering, Dick Jansson, WD4FAB (L) and AMSAT-NA Executive VP, Keith Baker, KB1SF, (R) inspect one of Phase 3-D's flight model solar panels in the P3-D lab at Weber State University, Ogden Utah. The panel is shown displaying the side containing its Kapton electrical insulation layer. Manufacture and donation of the solar panels to the Phase 3-D project was arranged through the hard work of a team of AMSAT volunteers led by Todd Tarrico, N6ZLJ, President of Thermal Equipment Company of Torrance, California. The panels would have cost the P3-D project well over $50,000 if purchased on the commercial market.

(AMSAT-NA Photo by Ralph Butler, Weber State University)



Dick Jansson, WD4FAB, inserts fasteners into the Phase 3-D solar panel protective covers at the P#-D laboratory at Weber State University, Ogden, Utah. The covers were constructed by Jansson along with Konrad Mueller, DJ7FDQ, of AMSAT-DL. Made from stock aluminum honeycomb material, the covers will be used to protect Phase 3-D's mounted solar cells during shipping and handling prior to launch.

(AMSAT-NA Photo by Keith Baker, KB1SF)

Sun Sensor for Aligning Satellite Antennas

by Darrel Emerson, AA7FV & G3SYS.

Darrel has a PhD in radio astronomy from Cambridge University in England and is employed by the National Radio Astronomy Observatory in Tucson, AZ. He works primarily with the 12m mm-wave telescope at Kitt Peak.

A disussion on the AMSAT Internet BBS recently raised the question of the best way to determine north in order to align satellite antennas. Several people suggested using the calculated position of the sun, and squinting along the antenna boom or watching the shadow of the sun as a way of determining true north and/or checking antenna elevation and azimuth alignment. This article describes an electronic sun sensor I've added to my AO-13 antenna setup. I got tired of squinting along the antenna booms at the sun to check alignment. I'm probably not the first to have done something similar. The entire installation should cost less than $10. I find it can easily detect the full moon as well as the sun. I took a 2-inch piece of plastic water pipe (e.g. 1 or 3/4 inch diameter), with endcaps. I use a CdS photoresistor (Radio Shack sells a packet of 5 for $2.29: item 276-1657. Only one is needed). Carefully mount the photocell inside one of the end caps, looking into the pipe, with the two wires going through small holes drilled in the endcap to the outside.

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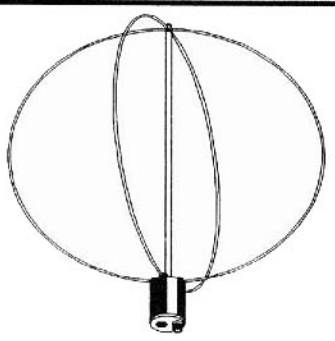

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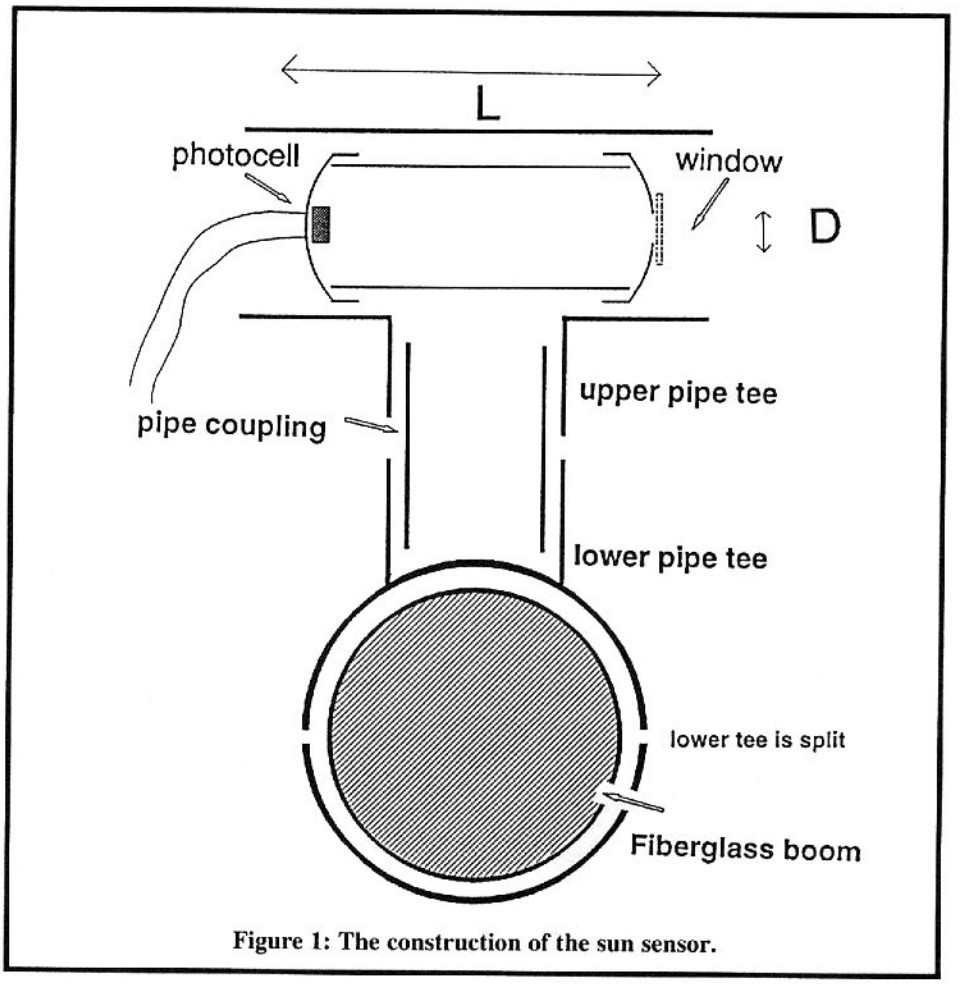

Figure 1: The construction of the sun sensor.

Drill a hole in the center of the other end cap, roughly the same diameter as the photocell. Cover the open hole with something transparent, like a piece cut from the bubble pack the photocells came in, glued to the outside of the cap. This is just to keep the rain out. Wire an rf bypass capacitor (e.g. 0.01 uF disc ceramic) across the two photocell wires, outside the pipe. You should now be holding a 2-inch piece of plastic pipe with caps on each end, see Figure 1, with two wires coming out of one end and a small window at the other end. Use other plastic plumbing components (T-junctions, adapters, etc.) to complete the construction as shown in Figure 1, and finally use hose clamps to attach the assembly to the cross-boom of your antennas (or anywhere else convenient on the antenna, but not close enough to detune any of the antenna elements.) Be careful to align the plastic pipe to be parallel to the antenna booms, with (obviously) the window looking along the direction of radiation. Now connect some twinflex to the two wires from the photocell, which are protruding from the rear endcap. In the shack, connect a cheap ohmmeter to the other end of the twinflex, and you've got a complete sun sensor. I use a Radio Shack analog multimeter ($4 at a hamfest: $10(?) at RS) permanently connected to the twinflex as the sensor readout. If you point the antenna towards the

sun, you will see the resistance of the photocell, measured by the multimeter, drop to a few hundred ohms. It's very easy to peak the antenna up on the sun this way, and then to compare your rotator readouts to the predictions of InstantTrack or your favorite sun tracking program. When you're sure everything is working, be careful to seal all the components against the weather. This is the only difficult part of the construction.

NOTES:

(1) When measuring the sun, the resistance of the photocell becomes a few hundred ohms. As the antenna slews towards the sun, the background sky brightness increases significantly. Figure 2 shows the response as the antenna was slewed in elevation across the sun. The vertical axis is the photocell conductance, in mhos (= reciprocal of resistance). There is a small sidelobe response about 9 degrees from the main peak which is caused by spurious reflections inside the tube. The half-intensity beamwidth is 8 degrees. This could be reduced by using a longer tube but even with an 8 degree beamwidth the central peak can be determined to better than one degree. Even if you start a long way from the sun, it's easy

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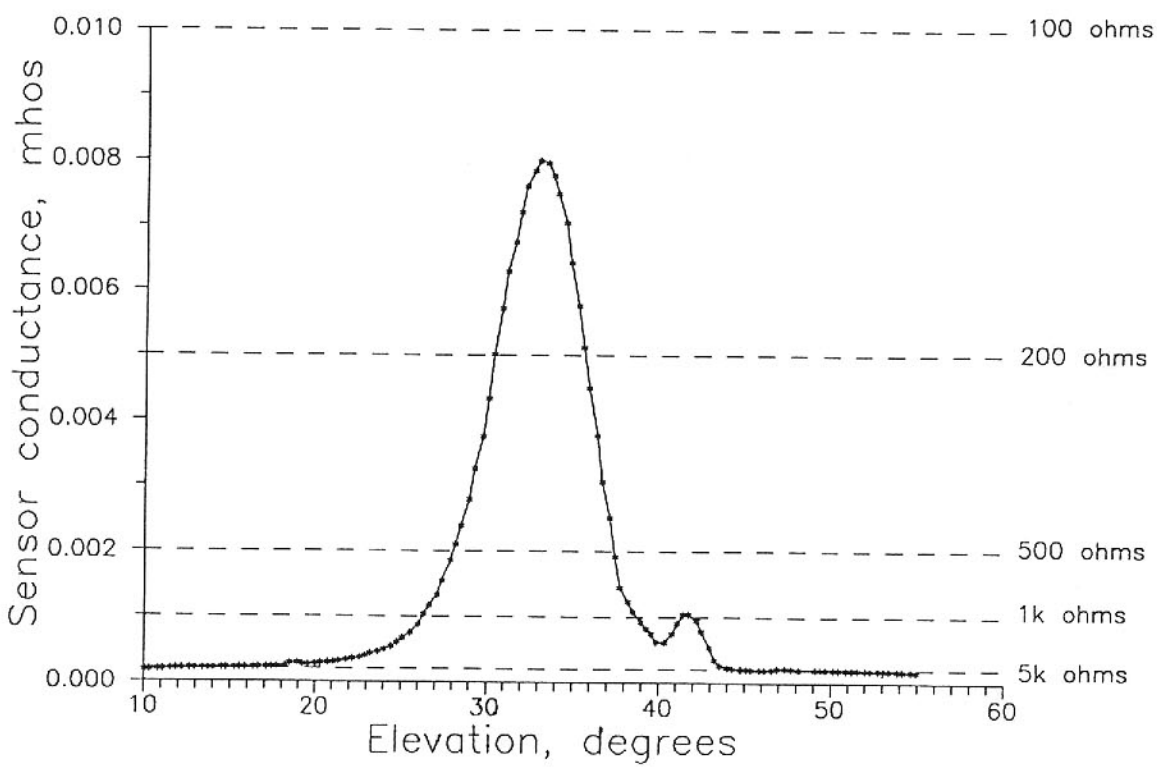

Figure 2: The measured sun sensor conductance vs. antenna elevation angle.

to home in using the changes in background brightness detected by the photocell, even on a cloudy day. Because the sensor effectively averages the brightness over many square degrees, you can usually peak up quite accurately towards the sun. (Of course this doesn't work well if the clouds are clumpy.)

(2) In the light of the full moon, in a clear sky, the photocell resistance becomes a few hundred kohms to a Megohm. It's not sensitive enough to detect changes in background brightness as the sensor approaches the moon. You have to get quite close to the correct settings before you can detect the moon at all. Although it's easy to detect the full moon, I've not managed to detect a half-moon. Something more sensitive than a simple RS multimeter might help here if that were important.

(3) The hole in the front endcap should be roughly the same diameter as the photocell. This allows maximum sensitivity. If it's much bigger, or much smaller, the response becomes flat-topped and it's a little more difficult to peak up exactly on the sun or moon. (4) The beamwidth of the sensor (between half-sensitivity points) is roughly arctan(d/L) where d is the diameter of the photocell and of the front window, and L is the length of the tube (in the same units, of course). For example, with a window 8 mm in diameter and a tube 60 mm (about 2.4 inches) long, the beamwidth will be about 8 degrees. Since it's then easy to peak the antenna to the center of the response, to better than 1 degree, this is probably a convenient beamwidth. (You'd be surprised how difficult it is to find the full moon if you make a sensor with a 3dB beamwidth of only 2 degrees.) If you want to have a narrower or wider response, use a longer or shorter tube.

Current Amateur Satellite Frequencies

Satellite	Callisgn	Uplink	Downlink	Type
AO-10		435.03-435.18 LSB/CW	145.975-145.825 USB/CW	Mode B Analog
AO-13		435.423-435.573 LSB/CW	145.975-145.825 USB/CW	Mode B Analog
AO-13		435.603-435.639 USB/CW	2400.711-2400.749 USB/CW	Mode S Analog
FO-20		145.9-146.0 LSB/CW	435.9-435.8	Mode J Analog
AO-27		145.85 FM	436.80 FM	Part-Time Repeater
RS-10		145.865-145.905 USB/CW	29.360 - 29.400	Mode A Analog
RS-12		21.21-21.25 USB/CW	29.41-29.4	Mode K Analog
AO-16	PACSAT	145.90, .92, .94, .96 FM	437.0513 SSB	1200 Baud PSK
DO-17			145.825 FM	1200 Baud AFSK/ voice
WO-18			437.104 SSB	1200 Baud PSK (img)
LO-19	LUSAT	145.84,.86,.88,.90 FM	437.1258 SSB	1200 Baud PSK
FO-20	8J1JBS	145.85,.87,.89,.91 FM	435.91 SSB	1200 Baud PSK
UO-22	UOSAT5	145.9, .975 FM	435.12 FM	9600 Baud FSK
KO-23	HL01	145.85, .90 FM	435.175 FM	9600 Baud FSK
KO-25	HL02	145.87 FM	436.5 FM	9600 Baud FSK
IO-26	ITMSAT	145.875, .90, .925., 95 FM	435.822 SSB	1200 Baud PSK
POSAT	POSAT1	145.975 FM	435.2777 FM	9600 Baud FSK

1) Frequencies shown are without Doppler compensation. For typical digital satellite pass the original signal will be about 8 kHz higher than what is shown.
2) WO-18 Webersat transmits experimental and image data and can be captured in KISS mode via PB or TLMDC.
3) Except for FO-20 the digital sats use a program suite containing PB/PG/PFHADD/PHS or WISP. The broadcast callsign (in PB.CFG) is the satellite's callsign with an SSID of -11. The connected mode callsign (in PG.CFG) is the satellite's callsign with an SSID of -12.
4) When in mode JD, FO-20 can be worked with any packet program. Connect to 8J1JBS. FO-20 currently alternates between modes JA and JD on a weekly basis. Check ANS bulletins for schedule.
5) AO-10 is no longer controllable but the transponder works when the satellite is in sunlight.
6) For AO-10 and AO-13, transmit LSB, receive USB. As transmitted frequency is increased the received frequency will decrease (inverting transponder).

(5) It is fairly critical to make sure the photocell is centered in the rear endcap, and that the window is centered in the front endcap. e.g. if one of these is "x" mm off-center, then the optical axis of the sensor will be roughly arctan(x/L) different from the mechanical axis of the pipe. A 1 mm error in positioning the window or the photocell will cause about a 1 degree squint with a 60 mm tube.

(6) I found that internal reflections from the sun, off the inside of the 2-inch tube, could cause confusing sidelobes when I was trying to home in on the sun. I ended up putting a tube of rolled-up, roughened black paper inside the pipe to minimize these internal reflections.

(7) I regularly check the alignment of my antennas, especially before events like a ZRO or EME test. I've often found that the antenna pointing has slipped by a few degrees, and that the rotator and mast-mounting hardware need tightening up. If I had a better mechanical mount for the antennas it probably wouldn't be so important. If the antenna alignment is not too far out, I do not try to realign the system mechanically. I measure how far the sun is from the calculated position, and then apply that as a correction offset when I point the antennas towards the satellite. It would be very convenient if software drivers used to control antenna rotators automatically allowed this zero-point error to be set as a parameter. Several commercial trackers do offer this feature.

(8) The most difficult part of the whole exercise is keeping the inside of the sensor, and the electrical connections, dry. Use all the usual techniques - silicon sealant etc. - that would be used on normal antenna connections.

Satellite Orbital Elements

by Ray Hoad, WA5QGD

Satellite	AO-10	UO-11	RS-10/11	AO-13	FO-20	RS-12/13	RS-15
Catalog Number	14129	14781	18129	19216	20480	21089	23439
Epoch Time	95045.85960153	95046.56017156	95046.22156292	95045.47450518	95043.19594349	95045.86946859	95046.54824140
Element Set	339	775	21	15	769	776	29
Inclination	26.5694	97.7806	82.9265	57.6414	99.0672	82.9219	64.8134
RA of Node	282.8718	54.8195	149.2197	203.8202	155.0645	191.4712	91.7100
Eccentricity	0.6019168	0.0011082	0.0013311	0.7262952	0.0540527	0.0029367	0.0167780
Arg of Perigee	252.4242	207.0415	70.0222	2.1919	156.0508	149.8997	283.1671
Mean Anomaly	36.3604	153.0216	290.2367	359.5469	206.6776	210.3850	75.0580
Mean Motion	2.05878612	14.69304196	13.72348199	2.09725598	12.83230064	13.74054117	11.27525542
Decay Rate	.00000205	.00000112	.00000038	-.00000472	.00000006	.00000048	-.00000039
Epoch Rev	8778	58604	38324	5108	23491	20197	580
Satellite	UO-14	AO-16	DO-17	WO-18	LO-19	UO-22	KO-23
Catalog Number	20437	20439	20440	20441	20442	21575	22077
Epoch Time	95043.24574911	95047.21076680	95043.78280625	95047.19104907	95043.23455558	95043.22913170	95043.33449374
Element Set	74	873	872	877	872	578	470
Inclination	98.5769	98.5863	98.5877	98.5872	98.5865	98.4110	66.0763
RA of Node	129.6029	135.0196	132.0509	135.3952	131.8118	117.5700	137.1671
Eccentricity	0.0010135	0.0010557	0.0010735	0.0011229	0.0011507	0.0007319	0.0012579
Arg of Perigee	204.3407	192.8871	202.4941	192.6688	203.9363	302.0114	230.1761
Mean Anomaly	155.7287	167.2043	157.5771	167.4212	156.1286	58.0358	129.8142
Mean Motion	14.29874443	14.29928687	14.30069215	14.30041655	14.30141684	14.36958381	12.86290017
Decay Rate	.00000014	.00000017	.00000013	.00000018	.00000035	-.00000005	-.00000037
Epoch Rev	26389	26447	26400	26449	26394	18755	11767
Satellite	AO-27	IO-26	KO-25	POSAT	MIR	MET-2/17	MET-3/2
Catalog Number	22825	22826	22828	22829	16609	18820	19336
Epoch Time	95043.69990406	95045.69548085	95043.75843484	95043.69810586	95047.20976127	95046.52900362	95046.80509661
Element Set	369	368	346	361	939	541	371
Inclination	98.6313	98.6303	98.6274	98.6283	51.6471	82.5389	82.5419
RA of Node	121.8081	123.8530	121.9697	121.9368	43.9703	75.0329	151.3061
Eccentricity	0.0007646	0.0008239	0.0009543	0.0009252	0.0004454	0.0015302	0.0018108
Arg of Perigee	227.1331	222.0688	210.6307	212.2460	129.0857	213.3417	16.6993
Mean Anomaly	132.9210	137.9858	149.4317	147.8157	231.0525	146.6779	343.4720
Mean Motion	14.27650866	14.27757931	14.28086521	14.28063337	15.57632655	13.84731409	13.16971478
Decay Rate	-.00000015	.00000001	.00000009	-.00000007	.00005408	-.00000001	.00000051
Epoch Rev	7200	7229	4011	7202	51417	35603	31532

AMSAT on the World Wide Web *Continued from Page 8*

booth at a hamfest. Amateurs are already aware that satellite operation exists, but may not know much about it. They need access to information about what is possible, and what is required to get started. They need contact information for AMSAT, and information on routine AMSAT activities. The Web can provide that information.

To the AMSAT community at large, the Web is a reference library. All sorts of information on satellite operation is available and up-to-date. If you need information on some satellites operating frequencies, check the Web. If you need current Keplerian elements, they're always available. And so on.

To the AMSAT research and development community, the Web is a way of sharing information about satellite projects with the world. As projects develop, information can be made available to any interested parties. Since the Web pages are easily updated, there is no problem with publishing information that may soon be outdated. Since the Web pages are always available, information doesn't disappear into dusty collections of back issues, inaccessible to newcomers, but remains readily available indefinitely.

The Magic Words

To jump to a particular page in the World Wide Web without using a link from some other page, you can enter a specifier called a Uniform Resource Locator or URL. The URL contains enough information to locate the server and to specify the page on the server. From there, you just select links to find additional related information. Once you get your Web browser working, you'll want to enter the URL for AMSATs *home page*, which provides links to all the pages of information on the AMSAT server. Here it is:

http://www.amsat.org/amsat

What's Available Now

Publications on the Web are always works in progress. Nothing is ever as complete as you would like, or as well organized, or as pretty. Nonetheless, in the five months the AMSAT Web server has been up, a fairly extensive collection of satellite-related information has been accumulated. Here's a short summary of what is available as of this writing.

- The introductory, or home, page contains a directory of available topics. In addition, a monthly feature article is available here. There's also a link to a page containing a summary of items that have recently been added to the server, so return visitors can find the new stuff quickly. (see Figure 1).
- Information about the organization includes a brief summary of the organizations purpose, information on publications, membership, donations, and available services. Two articles on AMSATs history and organization by Keith Baker, KB1SF, round out the summary.
- A list of information on other AMSAT organizations around the world and university groups working on amateur spacecraft is available, but incomplete.
- The current AMSAT News Service bulletins and John Maglicanes SpaceNews bulletins are always available. An archive of back issues is also available.
- Current Keplerian elements bulletins are always available in both NASA 2-line format and AMSAT verbose format. Tutorials on what the elements mean and how they are formatted are also available. A link to an Air Force FTP server provides access to non-amateur satellite elements.
- A page of information on every active amateur radio spacecraft features a picture of the spacecraft, historical information on the development and launch of the spacecraft, and full information on the uplinks and downlinks supported. Many of the satellites feature an article by John Maglicane, KD2BD, from his *Spotlight On:* series from the AMSAT Journal, and references to other relevant publications. The satellite information is rounded out by a summary of previous amateur radio spacecraft, and a collection of information on most of the new spacecraft under development. All the spacecraft information has been compiled by Steve Bible, N7HPR.
- A page of information on regular AMSAT activities includes details on local, regional, and international AMSAT nets, the AMSAT Operations Net on AO-13, and the ZRO test.
- A small but growing collection of FAQs and introductory articles on amateur satellites features the *Amateur Satellite FAQ* by Stephen Holmstead, N7TQL, and an introduction in Spanish by Ramó n Santoyo V., XE1KK. A tutorial on Keplerian elements taken from the documentation for *Instant*Track by Franklin Antonio, N6NKF, and summary of Keplerian elements formats are also available here.
- James Miller, G3RUH, has written many excellent articles on various aspects of amateur satellite operation over the years. James is in the process of placing these articles on the AMSAT FTP server for general reference. The Web pages make these articles easily available through your Web browser. At this writing, there are 19 articles available, totaling almost 55 thousand words, with 76 illustrations. In addition, James makes available AO-13 telemetry, updated monthly.
- The AMSAT Catalog gives descriptions of all the software, books, and trinkets that can be obtained from AMSAT for a donation. A few of the software descriptions feature images of the screens generated by the program. The AMSAT badges, decals, and patches are also pictured. Naturally, ordering information is provided.
- An extensive index of all the software available on the AMSAT FTP site makes it easy to find what you're looking for on the FTP site. (See Figure 2). The programs can be downloaded directly from the Web page, without running a separate FTP program.
- Detailed information on the mailing list services available on AMSAT.ORG, including a FAQ, are available on another page.
- Last but not least, a page is dedicated to links to Web pages and services related to the amateur radio space program offered by other organizations.

You Can Contribute

As you can see, the AMSAT Web pages are a collaborative effort. I would like to invite you to contribute. If you have any kind of collection of amateur space related information, whether of current interest or only historical interest, there is probably a place for it on the Web. If the collection is already available electronically, so much the better. If you have only paper, that is not an insurmountable problem. Text and images can be converted to electronic form using a scanner. If you have any such archives you'd be willing to make available, please contact me.

If you are interested in undertaking a project to organize and present some particular category of amateur satellite information, Id like to hear from you. I can help you get started with creating HTML documents. Its not very difficult technically the challenge is in the writing and the content.

I'm also looking for people with access to equipment for scanning in old articles and converting videotape into computer movie files. I hope to coordinate people with collections and people with equipment and time, to capture some of the old information in electronic form for publication on the Web.

Prospects for the Future

Much remains to be done. I hope to be able to offer many more articles from back issues of the AMSAT Journal and older AMSAT publications. I would like to make better use of the multimedia capabilities of the Web by offering sound clips of various events, and video clips of launches and SAREX video operations. It is even possible that some live connection could be made between an amateur radio satellite station and the Web. Many exciting things are possible.

At this writing, AMSATs FTP server and Web server are both operating on a computer at Qualcomm, Incorporated in San Diego, where I work. Thanks to Qualcomm for donating these facilities to AMSAT. At some time in the future, AMSAT may install a host of its own to facilitate development of more advanced services.

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A Beginner's Guide to OSCAR 13

By Keith Berglund, WB5ZDP

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AEA's ST-1 Satellite Tracker

Advanced Electronic Applications, Inc. has a solution for satellite tracking and tuning—the ST-1 Satellite Tracker. The ST-1 offers satellite users hardware and software for automatic satellite tracking and transceiver tuning. The ST-1 connects to your PC computer, your computer compatible transceiver, and your rotors. The ST-1 uses one serial and one parallel port. Pass through connectors allow use of ports when the ST-1 is turned off.

Here's how it works: As the satellite nears the horizon, the ST-1 points the antennas in the proper direction and tunes the rig to the right up-link and down-link frequencies. As the satellite moves into the field of view, the ST-1 controls the antennas' tracking. The ST-1 also controls transceiver tuning, correcting for the Doppler shift throughout the pass.

The ST-1 controls everything. If there is a file you want to retrieve from a satellite, type the file you want into your computer and the ST-1 does everything for you while you sleep, work—whatever! Using satellites couldn't be easier.

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- Allows unattended operation on Packet satellites.
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- Small size: 1.5" H x 10.5" W x 4.5" D
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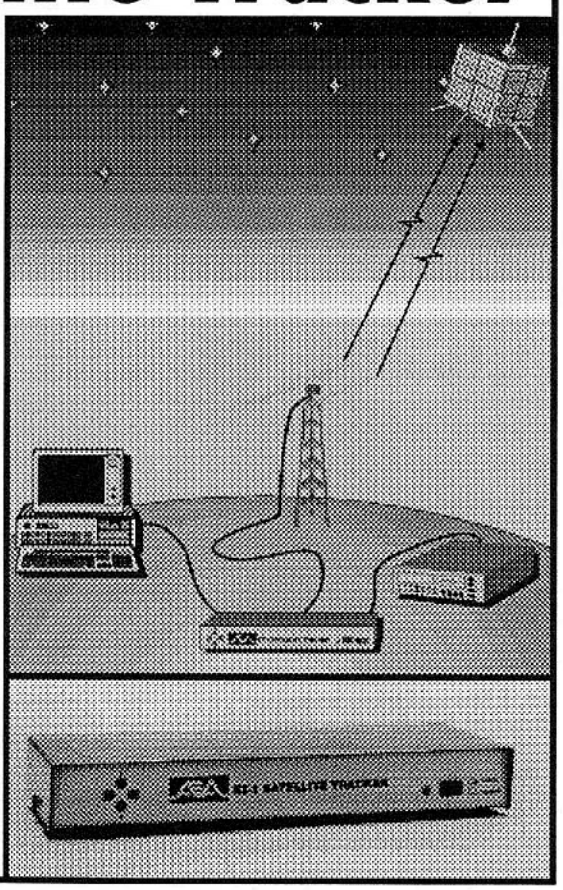

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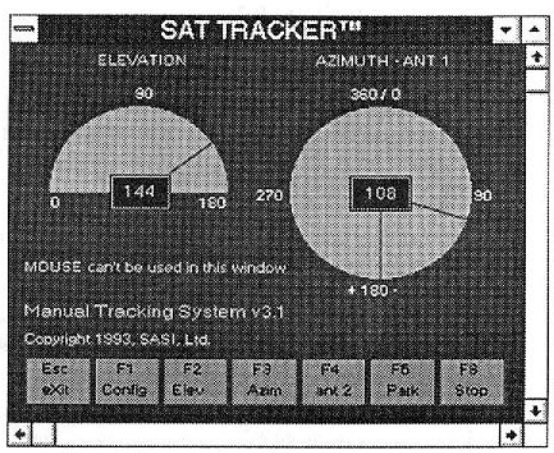

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The W4AMI Satellite Operator Achievement Award

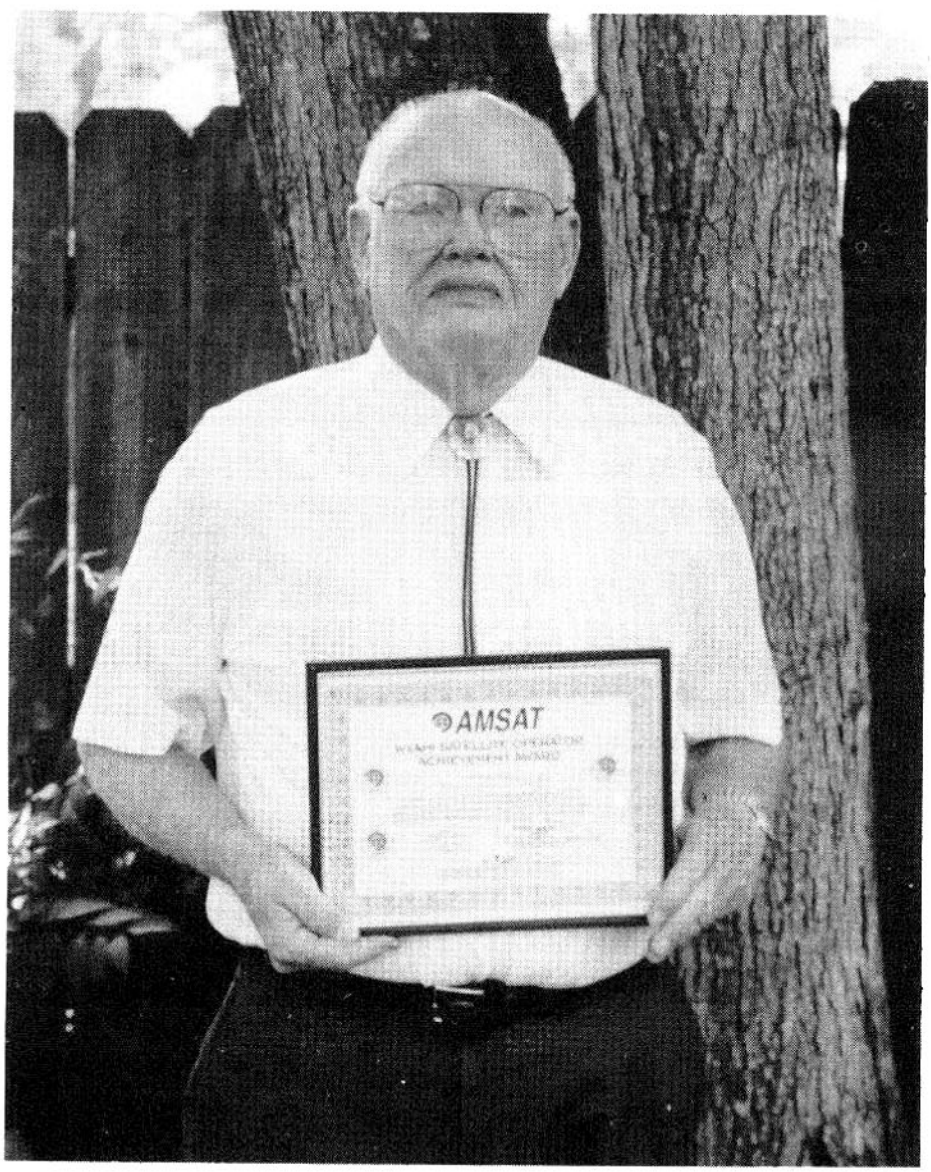
AMSAT has announced the W4AMI Satellite Operator Achievement Award for radio amateurs who have verified 1000 satellite QSOs. This award recognizes the achievements of Robert W. Barbee, Jr., W4AMI, a professional engineer and active amateur. Born in 1914, Bo Barbee became interested in radio at an early age and was licensed in 1930. At the University of Tennessee, Bob earned a degree in electrical engineering and began his lengthy career.

During World War II, Bob served as an engineer and officer in the U.S. Army. Following the war he returned to Memphis, Tennessee and was employed by Allen & Hoshall, a busy engineering firm. As a professional, Bob Barbee was instrumental in the construction of dozens of large projects, from hospitals to government buildings. Bob retired as Chairman of the Board of Allen & Hoshall after a career of four decades.

As an amateur, Bob has been a consistent experimenter and operator. From the early 1930's, Bob has been building and using his own gear and test equipment. W4AMI beam an avid satellite op upon activation of OSCAR 6. His shack is a virtual warehouse of rigs which have been used on Mode A, K, B, J, etc. and homebrew antennas are stored everywhere.

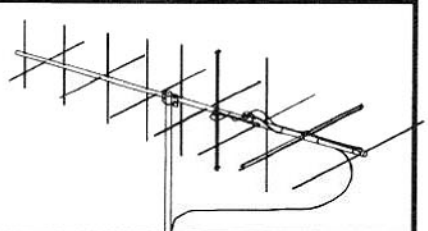
In addition to his technical ability, Bob has excelled as an operator with thousands of QSOs. W4AMI typifies the goals of AMSAT in that he is as busy an operator as he is a builder. His call is familiar to both the old-timers and the new operators around the globe. Currently Bob Barbee is active on Mode S. His current station equipment includes a twin homebrew helix antenna for the downlink and a homebrew down converter is under construction.

To apply for this award, eligible candidates must submit PHOTOCOPIES of logs verifying 1000 QSOs. Endorsements are available for each additional 1000 QSOs up to 4000. A special award is issued for 5000+ QSOs. Contacts may be analog or digital provided that all contacts are two-way and took place via OSCAR 6 or a later satellite. Multiple QSOs with any one station are permitted. Send COPIES (original logs will not be returned) of logs to Mark Rosenberg, AD4KS, 331 S. Yates Road, Memphis, TN 38120. Questions or correspondence should be sent to the above address. The cost of the certificate is $3.50 ($5.00 for non-AMSAT members. Make checks payable to AMSAT.



Robert W. Barbee, Jr. with W4AMI Satellite Operator Achievement Award No. 1 (AD4KS photo).

M² Circular argument?



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A Meeting of Amateur Radio Satellite Enthusiasts
in the Greater Washington, D.C. Area !!!

AMSAT LOCAL MEETING NOTICE

Sunday, March 19, 1995 at 1:00 p.m. EST

NASA/Goddard Space Flight Center Visitor Center Auditorium

Greenbelt, Maryland **Talk-In: WA3NAN/R 146.835 (-) MHz FM**

Enter from Soil Conservation Road Just north of Greenbelt Road (MD193).

Advance registration is NOT required for general admission.
Advance registration with P. Kilroy IS required for each presentation or demonstration.

All topics relate to amateur radio and the amateur space program. The format will be a combination of presentations and informal "show 'n' tell" demonstrations, as well as a social period.

Be sure to include your latest packet radio address on your local AMSAT survey sheet.

A donation of at least $3 is requested per person to help defray the associated meeting costs.

Extra Attractions: The GSFC Visitor Center will be open to the public on this meeting day, 10 a.m. - 4 p.m. This includes the Satellite Museum, Gift Shop, and Picnic Area.

There will be a "walking tour" of the NASCOM (NASA Communications) facilities at 11 a.m. and a model rocket launch demonstration by a local youth group at 1 p.m.

Visitor Center phone: 301-286-8981 Gift Shop: 286-6476.

Pat Kilroy, WD8LAQ Home: 301-249-3396 (before 9 p.m.) Work: 301-286-5910 (anytime)
Packet Radio: WD8LAQ @ WB3V.MD Internet: wd8laq@amsat.org

PacComm

PacComm has the most options for 9600 bps satellite work. All built from the G3RUH Direct FM design.

- The MC-NB96 modem card fits any PacComm TNC, or TNC-2 clone to upgrade it to 9600bps.
- The TNC-NB96 is a fully capable 1200 bps AFSK and 9600 bps DFM unit - push button selection of speeds and modes, no cable switching. Supports PacComm's PSK-1 Satellite Modem too.
- The SPRINT-2 High Performance TNC, for 9600 bps and higher. Serial port rates from 4.8 to 56kb. 10 MHz CPU clock speed, 128k RAM. Many other advanced features.
  - Standard model only $225
  - Satellite model allows simultaneous 9.6 uplink and 38.4 downlink for imagery satellites.

Packet Satellite Modems

PacComm has two ways to go for 1200 bps MicroSat access.

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A Message from the AMSAT QSL Bureau Mgr.

Walt Rader WA3DMF

Since taking over the AMSAT QSL Bureau from WB8OTH, I have gone through the unclaimed cards. Those OSCAR operators who have cards waiting at the Bureau runs almost two-thousand and their cards occupy considerable space. Thus, I must destroy them soon. In a final effort to distribute them to their rightful recipients, I am publishing this list of those with unclaimed QSLs. My thanks to Ron Marosko KK5KD for converting the list to electronic form.

For those listed, or any other satellite operators, for whom, cards may be sent to the Bureau, please send up to six S.A.S.E.s with your call in the upper left corner to the Bureau. In leu of U.S. postage, DX stations are asked to include enough IRCs to return each envelope sent.

AMSAT QSL Bureau
3702 Allison St.
Brentwood, MD 20722

AA1CN	NO1V	K2ZFW	W2SBI	KD3OJ	WB3IHJ	KB4TLH	N4JKV	WA4RHK	KA5PTC	NA5C
AA1GW	W1AIM	KA2AC	W2SFK	KD3VK	WB3IWW	KB4TLH	N4KAG	WA4RLC	KA5QNS	NK5F
AA1Q	W1AW/4	KA2CDJ	W2TZ	KE3HT	WB3SGB	KB4YML	N4KER	WA4TDS	KA5SFD	NS5B
AE1C	W1AW	KA2ERZ	W2UHI	KG3L	WM3M	KB4YTD	N4KHG	WA4UPD	KA5SMA	NW5B
AF1T	W1AYD	KA2ING	W2WCM	KI3I	WN3C	KC4CQR	N4KZ	WB4ABW	KA5VJB	NY5C
AF1U	W1CKA	KA2KOR	W2YLV	KI3S	WQ3Y	KC4HR	N4LYC	WB4ASQ	KA5VMC	NZ5C
AH1A	W1CVO	KA2MOV	WA2CYO	KY3T	AA4CM	KC4KQN	N4MIJ	WB4AXQ	KA5WRG	W5AHO
AJ1T	W1DBM	KA2OTX	WA2EXQ	N3AAT	AA4FQ	KC4OKG	N4MSE	WB4BCN/KL7	KA5YSY	W5AL
AT1T	W1DEA	KA2RDO	WA2FUZ	N3COB	AA4MD	KC4OND	N4MW	WB4BSJ	KB5ACA	W5BCB
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KA1MQX	W1YRM/KH2	N2AAM	WB2AHG	NX3B	K4FRM	KD4MFJ	NN4Q	WB4UYT	KE5BZ	W5LWE
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KA1SR	WA1ENO	N2BLI	WB2JVY	W3GA	K4GTQ	KD4WIZ	NY4W	WB4VMB	KE5IG	W5OHF
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WI0S
WI0T
WJ0G
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Before the

Federal Communications Commission

Washington, D.C. 20554

In the Matter of	)	
	)	
Allocation of Spectrum Below	)	ET Docket No. 94-32
5 GHz Transferred from	)	
Federal Government Use	)	

REPLY COMMENTS OF THE RADIO AMATEUR SATELLITE CORPORATION

The Radio Amateur Satellite Corporation (AMSAT) respectfully submits these Reply Comments in response to comments submitted to the Commission's Notice of Proposed Rule Making, ET Docket No. 94-32, released November 8, 1994 (the "NPRM").

I BACKGROUND

1. AMSAT, a not-for-profit District of Columbia corporation established in 1969, is the principal membership organization of the amateur satellite community in North America. Our current membership is approximately 7,500. Together with more than 30 of our affiliated organizations throughout the world, we have constructed, launched and operated over two dozen satellites to date in the amateur satellite service, of which the majority are presently in operation. These currently operational spacecraft include high-altitude, Molniya-type orbit transponder satellites capable of sustaining two-way communication over terrestrial paths well in excess of 10,000 miles (AMSAT-OSCAR 10 and AMSAT-OSCAR 13), numerous low-earth-orbit (LEO) digital store-and-forward packet radio satellites, scientific and educational payload satellites, LEO analog transponder satellites, and several spacecraft featuring combinations of these types of payloads.

II Provisions of the Reconciliation Act

2. The Reconciliation Act requires that the Secretary of Commerce identify at least 200 MHz of spectrum currently allocated for use by Federal Government agencies for transfer the FCC for use in the private sector. All of the 200 MHz must be below 5 GHz and at least 100 MHz must be below 3 GHz and 50 MHz of that must be available immediately. The Reconciliation Act also provides that, in making this allocation change, the Department seek to avoid "excessive disruption of existing use of Federal Government frequencies by amateur radio licensees".

In addition, the Reconciliation Act specifies that the Secretary shall consider, in analyzing the benefits from a particular reallocation, "the extent to which, in general, commercial users could share the frequency with amateur radio licensees."

Finally, the Reconciliation Act lists five possible grounds for the substitution or withdrawal of proposed reallocation frequencies, one of which is if: "the reassignment will disrupt the existing use of a Federal Government band of frequencies by amateur radio licensees". In view of the integral role in this reallocation process which the Reconciliation Act assigns to the Commission (including, for example, joint spectrum planning between the Commission and NTIA and sole responsibility for review and analysis of public comments in response to the NTIA's Preliminary Report, it is clear that it is the intent of Congress was to protect the amateur radio community from excessive disruption, and that at this point in the proceedings, the responsibility for such protection now rests on the Commission. We discussed this point at greater length in our comments as has the American Radio Relay League (ARRL) .

3. With the exception of the ARRL and Apple, none of the NPRM comments we have had the opportunity to review in the short time available, adequately address this important provision of the Reconciliation Act . AMSAT cannot express strongly enough, our agreement with ARRL with respect to this issue. For the reasons stated in ARRL's comments as well as our own comments, we believe that the Reconciliation Act requires (emphasis AMSAT's) the Commission to dismiss, as non-responsive, proposals which ignore or are inconsistent with this Congressional mandate.

4. The comments of LORAL/Qualcomm Partnership, LP (LQP) are a prime example. They do not even mention the words "amateur radio" or "amateur satellites". Instead, they propose to "grab" all 50 MHz Megahertz of spectrum now being transferred from Government use to the private sector for their particular project, non-GSO MSS; with no reference to the impact of such action on any other current or potential users,.

5. The comments of Southwestern Bell Telephone Company (SWBT) are another such example. While they do refer to "existing amateur operations in the 2390-2400 and 2300-2310 MHz band", and state that "sharing of this spectrum by wireless local loop systems and amateur operators is problematic, particularly in high population density areas"; they go on to urge the allocation of 2300-2310 and 2390-2400 MHz for "exclusive (emphasis AMSAT's) use in deploying wireless local loop technology". They do recommend that the Commission consider (emphasis AMSAT's) allocating another spectrum band (2402-2410 MHz for amateur use on a primary basis. In that limited respect, their proposal reflects those of ARRL which urged that the amateur service be given at least co-primary status from 2390-2450, and AMSAT's which suggested that the amateur service be given a primary allocation from 2390-2410 plus secondary status from 2410-2450 MHz and the amateur satellite service be given primary status from 2400-2410 MHz and secondary status from 2410-2450 MHz. Despite this "nod" in the direction of accommodating amateur radio; in AMSAT's opinion, their proposal falls far short of providing the protection of amateur radio intended by Congress in that it makes no showing whatever that WLL systems would not cause disruption of existing and near-term planned amateur radio operation in the 2300-2310 MHz and 2390-2400 MHz bands. Indeed, if SWBT's own Reply Comments on this point to the Commission's NOI are to be believed, this proposed use would not be compatible with amateur radio as much of SWBT's "local loop" application would be in residential areas where amateurs reside. It is evidently for this reason that SWBT desires an exclusive (emphasis AMSAT's) allocation in these bands. In our view, nothing would be more inconsistent with the intent of Congress in the Reconciliation Act than the removal of amateurs from presently-utilized spectrum as proposed by SWBT.

6. AT&T has cautioned against making new assignments in the 2400-2483.5 MHz range that might jeopardize its use for spread-spectrum Part 15 devices, especially for wireless LAN applications. They have said that sharing with the amateur services would be acceptable, but that they would want to prohibit any new non-amateur users in the 2402-2417 MHz segment. As we noted in our comments, we believe that such applications are generally compatible with continued amateur use of these frequencies. We are not aware of any significant interference problems which have arisen to date; moreover, as unlicensed Part 15 devices, such applications are required to protect amateur radio from interference and to accept any interference which they might receive from amateurs. We must point out, however, that it is not clear from AT&T's comments whether they are looking on amateur use of this band in terms of what they believe to be its present light level of occupancy. Current amateur use of the frequencies near 2400 MHz is not light when amateur satellites are considered, but such activity presently is of a downlink receive-only type. Other amateur activity in the band is, of course, two-way. Furthermore, both amateur and amateur satellite activity is certain to increase markedly with the launch of the Phase 3D satellite scheduled on the second engineering flight test of the Ariane 5 launch vehicle in April 1996. As stated in our comments, AMSAT believes that sharing with spread spectrum Part 15 devices such as discussed by AT&T (and also by IBM) is potentially possible. However, in furtherance of the intent of Congress in the Reconciliation Act, AMSAT requests that the Commission require AT&T, and other large commercial enterprises, desiring

to use this band for such applications and possessing substantial resources for the purpose, to conduct and submit to the Commission more extensive analysis on the effects of the operation of their equipment on amateur radio, including amateur satellite operation. The amateur community is not in a position to accomplish this, as it is not familiar with the specific characteristics of the emissions or susceptibility to interference of the equipment involved.

7. Apple Computer Co. is one of the few in the non-amateur sector which acknowledged the potential impact on amateur radio of action the Commission might consider in this proceeding. Apple even noted that the unique contributions made by amateurs depends on the availability of adequate spectrum. Apple states: "Each of these bands, and others in the amateur service, are essential components of a set of band segments extending through much of the radio spectrum. Each amateur band has certain characteristic attributes, in permitted signaling, in available bandwidths and in propagation, that allow hams to experiment, develop and use it appropriately for those band-specific attributes. Any change in the status of one band can affect other amateur bands. In the past the Commission has made allocation decisions affecting a single amateur band without addressing these secondary effects, resulting in an overall pattern of diminishing the spectrum available for the amateur service." Apple then goes on to suggest that the 2300-2310 and 2390-2400 MHz segments could be a case in point, and suggests that: "the Commission should make a package of coordinated decisions now, including;

- Retain the present allocation of the entire 2390-2450 MHz band to the amateur service, affirming that no primary services will be licensed, auctioned or otherwise, in the 2400-2483.5 MHz band;

- Increase that allocation to extend over the balance of the Part 15 band at 2450-2483.5 MHz, with the full understanding by all parties that, this increased allocation is only applicable domestically and thus is not suitable for satellite based systems.

- As discussed above, allocate the 2390-2400 MHz band to the "most compatible sharing partner" among the band contenders (footnote deleted) which would clearly be low power Part 15 Data PCS services secondary to the amateur service and

- Declare that the 2300-2310 MHz band will maintain an amateur-exclusive status and will not be considered for reallocation after that band is released by the Federal Government."

8. AMSAT supports the Apple approach. While we have no concrete information regarding the characteristics of the emissions they propose for the Part 15 data-PCS equipment nor its susceptibility to interference from amateur transmissions, their approach generally follows that proposed by us. We also see no objection to the limitation they propose with regard to 2450-2483.5 MHz not being available for the amateur satellite service, as any such allocation would have to be the subject of international negotiations, probably involving a WARC decision. In this portion of the spectrum, the 2400-245 MHz assignment represents adequate space for the amateur satellite service, particularly if 2400-2410 MHz is not subject to any new users and the amateur and amateur satellite services can be made primary in it. For the reasons cited in our comments, we particularly commend Apple for its recommendation with regard to the 2300-2310 MHz segment and urge the Commission to seriously consider all of their proposals.

III Technical Considerations

9. Many of the comments which AMSAT has had the opportunity to examine are deficient technically in one way or more. For example, LQP urges allocating 2390-2400 MHz for mobile satellite uplinks and 2402-2417 MHz for mobile satellite downlinks. In doing so, they fail to address the impact of their proposal on amateur radio or the possibility of sharing with the amateur and amateur satellite services. AMSAT contends that LQP makes marginal technical representations as to how and why non-GSO MSS will use this particular spectrum. In affect, they bluntly say to the Commission, "Give us all the spectrum available and we'll figure out how to use it later." Specifically, they make what we consider only passing reference to interference from ISM and Part 15 devices, stating their belief that: "ISM and Part 15 use would have insignificant (emphasis AMSAT's) impact on non-GSO MSS downlinks in this band. (Footnote deleted).

However, in their previous filing, they stated: "LQP believes that the Commission should immediately advise NTIA that the 2402-2417 MHz band appears to have little potential for commercial services and seek to have NTIA identify other spectrum for inclusion in the 50 MHz to be made available this year." In AMSAT's opinion, this abrupt change of heart concerning the usefulness of the 2402-2417 segment calls into question LQP's entire technical analysis of how any portion of this spectrum can be used for their intended application. Indeed, observations by amateur satellite operators show that interference from microwave ovens is present even at frequencies as low as 2400 MHz. Amateur satellite operators' use of this portion of the spectrum, involves highly directional antennas which tend to reduce interference form nearby microwave ovens. On the other hand, LQP's proposed application, could be expected to employ hand-held transceivers with simple non-directional antennas. Furthermore, the bandwidths involved would probably exceed the approximately 3 kHz customarily used by amateur satellite operators to receive "S Band" downlink signals from the AMSAT OSCAR-13 satellite. It can only be concluded that LQP would expect to employ quite high PFDs in order to override interference from nearby microwave ovens, not to mention Part 15 devices which are becoming more and more prevalent especially in industrial and office environments where usage of hand-held MSS terminals would be expected to be common. Such high PFDs will, of course, lead to higher costs for MSS spacecraft and possibly cause interference to terrestrial services such as the aforementioned Part 15 devices. The high level of interference in this band, might even lead to significantly diminished utility of the MSS service. In this case, the Commission presumably would be asked to take steps to clear up the interference, or the MSS service would have to be moved to another part of the spectrum. Either course would be extremely costly to all concerned.

10. SWBT's proposal to establish wireless local loop service in the 2300-2310 and 2390-2400 MHz bands is, also not well thought out. First, such a service could suffer interference from microwave ovens in the vicinity of 2400 MHz.. It is also conceivable that it could cause interference to Part 15 devices operating between 2400 and 2483.5 MHz.. In addition, although we do not have specific knowledge, and SWBT provided little in the way of detail with regard to the capability of their system, it appears that the WLL technology they propose would accommodate only relatively low bandwidth applications, i.e. voice and low data rate digital data. This might be appropriate to support today's needs. However, with the prospect of telephone companies bringing wideband video services into homes, it would seem that any new system being constructed should be capable of supporting that application. AMSAT wonders if the two 10 MHz wide segments being proposed for WLL by SWBT will be capable of handling multiple channels of full motion, possibly high definition, video to a number of homes simultaneously. If it cannot, we believe that it would be a mistake for the Commission to allocate valuable spectrum to a new service, that may well prove to be obsolete before it is even built. Would it not be preferable to develop WLL technology to the point that it could support the needs of the National Information Infrastructure (NII), in a much higher portion of the spectrum where far wider bandwidths can more readily be accommodated?

AMSAT takes exception to SBWT's contention that higher frequencies would not be suitable from the propagation standpoint. The experience of radio amateurs and others clearly demonstrate that frequencies far higher than 2.4 GHz can be, and in fact are being, used for wideband communication over the typical paths and ranges involved in SWBT's proposed service. We contend that almost any frequency could be used for the short ranges involved. In addition to providing greater bandwidths and avoiding additional congestion in this already crowded part of the spectrum, the use of higher frequencies for WLL systems provides other significant advantages. Through the use of simple, small, directive antennas on the poles, or other outside terminal locations; security and interference rejection can be improved significantly. In addition the ability to reuse spectrum will be greatly enhanced.

11. Nevertheless, if the Commission should decide to authorize the type of WLL system being proposed by SWBT, despite its apparent near-

term obsolescence and other weaknesses, AMSAT contends that it should consider other frequency segments for it. There are two major reasons for this. First, the provision made by Congress in the Budget Reconciliation Act with respect to protection of amateur radio, cited above. Second there is the potential for interference from microwave ovens as well as interference from and to Part 15 systems., also already discussed. Particularly since WLL would involve relatively low power and short range, it could probably share with other services which would generally not be located in close proximity to homes and offices. Therefore, if the Commission feels that it must place WLL in this part of the spectrum, it might examine the possibility of assigning it 2310-2320 and 2380-2390 MHz or some other set of segments between 2320 and 2390 MHz. We are aware that some of this spectrum has been selected by the U.S. for BSS (sound). However, world pressures are likely to lead this country into adopting the same allocation for that service as the rest of the world, and thus forcing a move of airborne telemetry to the vicinity of 2350 MHz; a portion of the spectrum it was given when the 80 MHz segment from 2310-2390 MHz was withdrawn from the amateur service in 1984. WLL and airborne telemetry would appear to make rather ideal sharing partners.

12. As for interference to radioastronomy activities at Arecibo, PR, whether WLL operates at 2380 or 2390 MHz would appear to make little difference. The system would probably not be able to be used within a certain distance from the site in either case. Such a restriction would appear to be minor in comparison with the presumed benefits form it employment in the rest of the country.

13. AMSAT agrees with the statement of IBM: "The NPRM's proposals to reallocate this band are all the more puzzling because of the overwhelming record evidence that the presently cluttered state of the band would provide new licensed users with very little of value. Indeed, in its August 1994 report to NTIA, the Commission recognized that "[r]eallocation of the 2402-2417 MHz band presents little or no additional benefit to the public. (footnote deleted) The Commission based its findings in part on the substantial interference concerns present in the 2402-2417 MHz band."
IBM then goes on to quote the Commission's own words in the referenced report: "This would make it extremely difficult for any licensed communication system to operate and would greatly reduce the advantage of using advanced technologies . . . . [I]mplementing a communications system in this band will cost up to 50 times as much as a system operating in a band without interference from ISM devices." (footnote deleted)

IBM further states: "It makes little sense for the Commission to destroy Part 15 use of the spectrum, with its significant public benefits, in order to allocate the band to possible uses for which technology has not yet been -- and may not be -- invented." AMSAT not only agrees with IBM in this statement, but further submits that affording the amateur service and the amateur satellite service continued access to this spectrum, as urged in the comments submitted by AMSAT and ARRL, will better foster continued technological development than would reallocating it to some untested technology which might not be able to economically utilize it because of existing and increased interference from Part 15 and Part 18 devices.

14. AMSAT also agrees with the statement of IBM: "Moreover, allocation of this spectrum to its incumbent uses best meets the statutory criteria enunciated by Congress in the Omnibus Budget Reconciliation Act of 1993 as amended, 47 U.S.C. §§ 923, 925." As we stated in our comments filed on the Docket, AMSAT believes that amateur radio can share spectrum with spread spectrum Part 15 systems. As we said in reference to AT&T's proposal, however, we must caution that it is incumbent on those proposing such systems to include in their design an inherent resistance to interference. Otherwise, users are later liable to seek compensation from the manufacturers or attempt to have the Commission resolve interference problems by asking it to restrict operation of legitimate licensed services (in this case the amateurs) which occupied the spectrum prior to the design and deployment of the Part 15 systems.

IV Economic Considerations

15. While it might be considered outside the scope of this proceeding in a literal sense, AMSAT is of the opinion that a motivating force in the Commission's decision process on this proceeding is the desire to raise revenue for the U.S. Government through spectrum auctions. Thus the Commission may be inclined to follow a course other than that recommended by AMSAT, ARRL, IBM, AT&T, Apple and others to retain access to this spectrum for its present users, including the amateur service, amateur satellite service and Part 15 devices. However, we believe that any short-term benefit the Government might gain from such revenue would be more than offset by later costs and inefficiencies to the economy as a whole caused by the already-cited interference conditions associated with these band segments. Although the principle of spectrum auctions has become well established and has proven quite successful, AMSAT believes, as do IBM and others participating in this proceeding, that this is simply the wrong portion of the spectrum for auctioning to new users. Nowhere is this view more eloquently stated than by the Commission itself: "One area of the reallocation plan presented in the Preliminary Report that needs to be addressed is the 2402-2417 MHz band. Reallocation of 2402-2417 MHz band presents little or no additional benefit to the public." In addition, Congress has made it abundantly clear that; "the Commission may not base a finding of public interest, convenience and necessity on the expectation of Federal revenues." Thus AMSAT contends that auctions at 2390-2417 MHz, or parts thereof, would be clearly inconsistent with the requirements of the Reconciliation Act, in addition to its already cited provisions dealing with the protection of amateur radio.

V Complying with the Reconciliation Act

16. AMSAT contends that by following the recommendations of ARRL, AMSAT and other amateur groups and individuals commenting, as well as those of IBM and AT&T and Apple; and rejecting those of other entities proposing to license new services in the spectrum in question; the Commission will be complying with the intent of the Reconciliation Act. All of those users arguing for not licensing new services to this spectrum represent private sector users. Thus the Commission will be making this spectrum available to the private sector as intended by the Reconciliation Act. Nowhere does the Reconciliation Act require that all of the spectrum released by NTIA be allocated to new licensed services if unlicensed and existing licensed services are, as we believe, better suited to making best use of the spectrum in question.

VI Conclusion

17. For the reasons discussed above, AMSAT reaffirms its recommendation that te following actions be taken:

a. Establish an amateur and amateur satellite allocation from 2400-2410 MHz on a Primary basis with no additional sharing partners other than the existing ISM assignment and spread spectrum Part 15 devices.

b. Retain access for the amateur service to 2390-2400 MHz and for the amateur-service to 2410-2450 MHz,

AMSAT also supports the ARRL recommendation that the amateur service be given Primary

status on the entire band 2390-2450 MHz..

Respectfully Submitted,

The Radio Amateur Satellite Corporation
PO Box 27
Washington, DC 20044

By _____
William A. Tynan
President

January 5, 1995

Before the

Federal Communications Commission

Washington, D.C. 20554

In the Matter of	)	
	)	
Allocation of Spectrum Below	)	ET Docket No. 94-32
5 GHz Transferred from	)	
Federal Government Use	)	

COMMENTS OF THE RADIO AMATEUR SATELLITE CORPORATION

The Radio Amateur Satellite Corporation (AMSAT) respectfully submits these comments in response to the Commission's Notice of Proposed Rule Making, ET Docket No. 94-32, released November 8, 1994.

BACKGROUND

1. AMSAT, a not-for-profit District of Columbia corporation established in 1969, is the principal membership organization of the amateur- satellite community in North America. Together with over 30 of our affiliated organizations throughout the world, we have constructed, launched and operated over two dozen satellites to date in the amateur-satellite service, of which the majority are presently in operation. These currently operational spacecraft include high- altitude, Molniya-type orbit transponder satellites capable of sustaining two-way communication over terrestrial paths well in excess of 10,000 miles (AMSAT-OSCAR 10 and AMSAT-OSCAR 13), numerous low- earth-orbit (LEO) digital store-and-forward packet radio satellites, scientific and educational payload satellites, LEO analog transponder satellites, and several spacecraft featuring combinations of these types of payloads.

2. Additional satellites for the amateur-satellite service are planned or are presently under construction by AMSAT and its affiliate organizations in Argentina, Chile, Israel, Japan, Korea, Mexico, Russia, and the United Kingdom, among others. Groups in other countries such as the Philippines and Indonesia have discussed the possibility of building amateur satellites. Many of these groups are associated with universities or have access to government or industry facilities in their countries. Indeed, owing to the worldwide and cooperative nature of amateur radio, the construction of satellites for the amateur- satellite service has emerged as a principal means of technology transfer to developing countries. One not-for-profit organization, Surrey Satellite Technologies Ltd., affiliated with the University of Surrey in the United Kingdom, has built or aided in the construction of eight such satellites, with more on the way. AMSAT itself is currently working with amateur- satellite construction groups in nearly a dozen countries to build the fourth and most advanced in a series of elliptical orbit amateur satellites called "Phase 3D". The future is certain to see a further proliferation of this highly beneficial activity, provided that suitable spectrum is maintained for its use.

DISCUSSION

3. Title VI of the Omnibus Budget Reconciliation Act of 1993 (the "Reconciliation Act") requires that the Secretary of Commerce shall seek to avoid "excessive disruption of existing use of Federal Government frequencies by amateur radio licensees". In addition, it specifies that the Secretary shall consider, in analyzing the benefits from a particular reallocation, "the extent to which, in general, commercial users could share the frequency with amateur radio licensees." In view of the integral role in this reallocation process which the Reconciliation Act assigns to the Commission (including, for example, joint spectrum planning between the Commission and NTIA , and sole responsibility for review and analysis of public comments in response to the NTIA's Preliminary Report, it is clear that the intent of Congress was to protect the amateur radio community from excessive disruption, and that the responsibility for such protection rests as much on the Commission as on the Secretary of Commerce and the President. Clearly, this is the case now that the spectrum in question has been transferred to the FCC by the Commerce Department for administration. As noted in in its Preliminary Report , NTIA excluded 2400-2402 MHz from the proposed reallocation because of its realization that these frequencies are of vital importance to spacecraft operations in the amateur- satellite service. While AMSAT commends NTIA for this action, it falls far short of what is realistically needed in the foreseeable future. AMSAT anticipates greatly increased demand for amateur-satellite operations in this portion of the spectrum, far more than can reasonably be accommodated within a 2 MHz band. It is certainly too restricted to accommodate such wideband techniques as spread spectrum and fast-scan television, even if compression techniques are employed. AMSAT firmly expects to employ such modes on future spacecraft. The 10 MHz wide 1260-1270 MHz uplink-only amateur-satellite service allocation is available for such applications, and a similar bandwidth is needed as a downlink at 2400-2410 MHz. Obviously, such wideband techniques cannot be accommodated in lower frequency bands due to inadequate allocated bandwidth. The next highest amateur-satellite allocation (3400-3410 MHz) is available in Regions 2 and 3 only and thus is not suitable for the worldwide coverage required of amateur satellites. While plans are underway to test the suitability of amateur-satellite allocations at 5, 10 and 24 GHz, it is not clear that equipment for these bands will be readily accessible to amateurs in less developed countries, nor even less-affluent amateurs in the developed countries. Therefore, the combination of the 1260-1270 MHz band as an uplink and a 10 MHz-wide band at 2.4 GHz is necessary for the near-term future development of the amateur-satellite service. While it is true that the amateur- satellite service is allocated 2400-2450 MHz, the upper portion of that band is not suitable for weak-signal reception, characteristic of amateur satellites, in residential areas where most amateurs reside because of the large number of microwave ovens operating in the vicinity of 2450 MHz. These facts dictate that the amateur-satellite service have access to 2400-2410 MHz for use as downlinks on current and future satellites.

4. Current amateur operation in the 2.4 GHz band, and all other assignments from 420 MHz to 10 GHz, are on a Secondary basis. This has worked quite well when the amateur services were sharing with Government, mostly radiolocation devices, many of which were on ships at sea or on foreign soil. However, in the cases where amateurs share with commercial users, such as in the 902-928 MHz band, a greater number of conflicts have arisen. AMSAT contends that commercial users, who may have paid large sums for access to spectrum, are most unlikely to be willing to share their expensive bounty with amateurs. From the amateur standpoint, such sharing will not be successful, especially where the amateur application involves the reception of relatively weak amateur-satellite downlink signals or very weak signals associated with long-distance terrestrial operation or earth-moon-earth communications. There are some specific proposed uses for these frequencies which, AMSAT believes, would not be compatible with sharing with amateur operation. For example, we agree with the comments of Southwestern Bell Corp. (SBC) that its proposed use of this spectrum as a "local loop" would clearly not be compatible, as much of that application would be in residential areas where amateurs reside. We believe that there would be excessive disruption to the amateur services and unacceptable interference in both directions if amateurs and such "local loop" service were forced to share spectrum. On the other hand, AMSAT contends that sharing with certain types of non-amateur users is feasible. One such example is that of spread spectrum Part 15 devices, which are presently active in the 2400-2450 MHz band with no problems that have been made known to us. This view is reflected by AT&T in its comments on the NOI. Extending down to 2390 MHz the spectrum available for such devices, on a shared basis with amateur radio, would, in AMSAT's opinion, provide additional capability to such devices, provide needed spectrum for amateur radio and protect the radio astronomy work being conducted at Arecibo, Puerto Rico. Most other proposed applications of the spectrum will not provide such protection without specific restrictions, which might well prove difficult to enforce and costly to all concerned.

5. Unlike commercial satellite services for which the use of geostationary spacecraft is economically feasible and common, the high costs of launch and on-station maintenance have so far made these types of spacecraft economically prohibitive for amateur radio use. For this reason, among others,, the amateur-satellite service currently utilizes satellites in low Earth orbits or highly elliptical orbits, which serve all or most of the globe with one set of uplink and downlink frequencies. For this reason, amateur-satellite frequency allocations must be coordinated internationally so that they are

available for use on a worldwide basis. Any reallocation of frequencies affecting the amateur-satellite service in the 2400-2450 MHz band, including the introduction of additional or substituted sharing partners in the United States, cannot help but have adverse effects on the entire service worldwide, and thus must be coordinated with all other national administrations through the ITU process.

6. Although current amateur and amateur-satellite use of the 2.4 GHz band may be considered light by standards used to judge other parts of the spectrum, the use of this band is expected to increase greatly in the next few years, particularly with the launch of the Phase 3D amateur satellite in April 1996. Like other users of the radio spectrum, amateurs tend to migrate from lower frequencies to higher frequencies as time passes, suitable equipment becomes available and the state- of- the-art advances. Amateur radio is also unlike many commercial users of the spectrum in that amateurs are a diverse group, both geographically and in terms of economic status. A large commercial organization can be given access to spectrum and then can produce, or have produced in a relatively short time, the necessary equipment to use that spectrum. Amateurs, on the other hand, must wait for a few very intelligent and technically sophisticated individuals, or a handful of manufacturers, to see the need and come up with suitable equipment. Then most individual amateurs must either construct the equipment from magazine articles or purchase the newly created commercial equipment. Currently, there is very little commercial equipment available for the 2.4 GHz band. However, with the launch of Phase 3D, equipment availability and occupancy on this band is certain to increase markedly. Another factor is that commercial equipment for the amateur market generally becomes available for higher frequencies as time passes. For example, a few years ago, very little equipment was available for the 1240-1300 MHz band. Now, several quite serviceable units for that band are on the market. So, AMSAT contends that it is not appropriate to judge whether or not certain frequencies in the microwave bands should be retained for amateur use, based strictly on current occupancy. Equipment availability, and indeed the level of interest on the part of amateurs, is also greatly influenced by the future prospects for a band. In the case of the 13 cm band (2300-2310 and 2390-2450 MHz), amateurs originally had access to the entire 2300-2450 MHz band. The 2310-2390 MHz portion was withdrawn several years ago, ostensibly to provide for flight test telemetry. That use was never made of this 80 MHz of spectrum and more recently, part of that range was made available for Digital Broadcasting (sound). This was after the airborne telemetry interests adamantly stated that it would be too costly for them to move from 1.5 to 2.3 GHz. Thus, the U.S. became one of the few countries assigning 2.3 GHz to Digital Broadcast (sound), instead of 1.5 GHz as most of the rest of the world does. So amateurs lost a large chunk of spectrum in the name of national security, to an application which the supposed users did not want to put there. This, in conjunction with the new threat posed by the present proceeding, has certainly diminished the interest of commercial companies in producing 2.4 GHz equipment and represented a deterrent to amateurs to making investments in equipment for the band. Thus, looking at current amateur activity in the 2300-2310, 2390-2450 MHz band, in the midst of past reallocation actions and a proposal to withdraw more of the band, becomes somewhat of a self-fulfilling prophecy. If amateurs lose 25 MHz more at this time with no assurance that 2300-2310 MHz will not also be lost in a few years, how much commercial equipment can be expected to be offered for this part of the spectrum, and what level of commitment can amateurs be expected to devote to it? It should be unnecessary to remind the Commission that amateurs in recent years have also lost 220-222 MHz and, in some parts of the country, 420-430 MHz.

7. It might not be apparent why AMSAT is concerned with segments of the amateur bands which are not authorized for the amateur-satellite service. However, any spectrum lost by amateur radio puts additional pressure on the amateur-satellite segments as other amateurs crowd into them. A prime example is in the 435-438 MHz amateur-satellite service band. With the loss of 420-430 MHz in parts of the country and threats to it in the rest, more and more amateur television operators are using the 435-438 MHz amateur-satellite service segment, resulting in interference to amateur-satellite communications. Thus, it is quite logical to conclude that loss of 2390-2400 and 2402-2417 MHz, and the threat to 2300-2310 MHz, would have a similar impact on the remaining /segments, 2400-2402 and 2417-2450 MHz. As already stated, use of that latter segment by amateurs is already jeopardized by the presence of ISM devices, especially microwave ovens.

8. A discussion of current and past amateur-satellite usage of the 2.4 GHz portion of the spectrum was presented in AMSAT's comments on the FCC's Notice of Inquiry. For reference, this material is updated here as Appendix A.

9. The intense crowding taking place on the lower VHF and UHF amateur bands necessitates the use of the higher-frequency bands by amateur satellites. Particularly bad is the situation in the 144-146 MHz band, where the amateur service and the amateur-satellite service are co-primary. This is the only portion of the VHF spectrum presently allocated to the amateur-satellite service on a Primary basis by the ITU. Because of intense usage by other amateur applications, the only part of this band that can regularly be used by the amateur-satellite service is 145.8-146.0 MHz. Co-channel and adjacent-channel interference, a direct result of the intense crowding, is increasingly making the band difficult to use for satellites, especially for the relatively weak-signal satellite downlinks. In addition to legitimate amateur use of the band, the ready availability of inexpensive equipment intended for the amateur market has resulted in extensive use of this band by non-amateurs for personal and commercial communications in many countries, especially in Central America, Asia and the Pacific Rim, despite ITU regulations to the contrary. First-hand observations by radio amateur astronauts flying in the Space Shuttle and cosmonauts aboard the Russian space station MIR have confirmed that this is a significant and growing problem for amateur space communications. The narrow band available to satellites and these various kinds of interference make migration to higher frequencies all the more urgent.

10. A similar situation is developing in the 435-438 MHz band allocated on a secondary basis by the ITU to the amateur- satellite service. In many parts of the world, use of this band for satellite uplinks is rendered virtually impossible at times by the presence of high-powered radar stations such as PAVE PAWS. This has proven especially true with respect to digital applications, such as packet radio and earth-to-space command links.

11. Two internal problems facing amateur radio are the proliferation of modes of operation, many inherently wideband in nature, and the increasing number of amateur radio operators since institution of the code-free license. Figures indicate that the number of licensed amateur stations in the U.S. is growing at the rate of approximately 7.5 percent per year, with most of that growth attributed to the no-code Technician License. Both of these situations will require greater use of the microwave bands for amateur satellites in coming years, especially the 2.4 GHz band paired with the 1260-1270 MHz uplink-only band. A mode of operation, growing in popularity is fast-scan amateur television. Several manufacturers currently offer low-cost amateur television transmitters for the 420-450 MHz band. As no such amateur television equipment is manufactured for any of the amateur bands above 450 MHz, this band is receiving the brunt of amateur television operation. Since amateur FM repeaters occupy almost all of the 440 to 450 MHz range, and 420 to 430 MHz is not available everywhere in the U.S., most amateur television operation takes place between 430 and 440 MHz. Many of these commercial amateur TV transmitters, and most home constructed units, transmit signals 8 MHz in width (both sidebands), often causing interference to reception of amateur satellites in the 435 to 438 amateur-satellite service band as well as to weak-signal experiments taking place near 432 MHz. This problem is greatly exacerbated in the many other countries of the world where only 430-440 MHz, or parts thereof, is available for amateur operation.

12. Amateur satellites are completely different from satellites built for other applications. In the case of commercial or government satellites, while the spacecraft is being constructed and prepared for launch, suitable ground station equipment is being developed and deployed. Usually, both of these are funded and directed by the same company or government agency. This assures that the ground equipment will be in place when the space segment comes on line and that the two will be compatible with one another. This is not true with amateur satellites. In this case, the space segment is constructed by a specific amateur group such as AMSAT, or a collection of such groups. In planning the satellite, the constructors attempt to understand the current and future capabilities and needs of individual amateurs throughout the world. This often means that they must compromise in the design of the satellite, frequently choosing lower frequency bands and lower speed data rates than would be optimal otherwise. This puts the

amateur-satellite builders in a serious bind. If the lower bands are too narrow and crowded, and the higher ones offer a greater challenge than can be placed on people in poorer countries, then the low microwaves (1.2 and 2.4 GHz) become the only acceptable choice. The next highest amateur-satellite band, 3400-3410 MHz, is not available worldwide, and therefore is most unlikely to be used for amateur satellites unless a worldwide allocation can be obtained. Thus, it is the 2400 MHz band which will bear the greatest burden of supporting the growth of the amateur-satellite service in the future, especially since the use of 1.2 GHz for amateur satellites is restricted to uplinks only under ITU regulations. But it is difficult to see how the 2.4 GHz band can accommodate this demand if only 2 MHz of spectrum is available.

13. Currently, the amateur-satellite service allocation in the 2.4 GHz region is 2400-2450 MHz, both in the U.S. and international tables. It would appear that to efficiently use the 10 MHz wide 1.2 GHz uplink assignment, a like assignment at 2.4 GHz would be reasonable and necessary.

14. While there is some commonality of technical interest between amateur operators who use narrow band weak-signal modes, such as earth-moon-earth or long-haul terrestrial means of propagation, and those amateurs participating in satellite operation; use of common or nearby frequencies by these two groups often leads, in practice, to mutually destructive interference. Furthermore, relatively narrow allocations, available on a primary basis, form the best approach of accommodating and encouraging both of these potentially valuable activities. Currently, most amateur weak-signal experimentation in the 2.4 GHz band is conducted in the vicinity of 2304 MHz, although in some countries other frequencies are employed due to non-availability of the 2300-2310 MHz segment to amateurs. Like satellite operation, although to a lesser extent, weak-signal operation is best accomplished on common worldwide allocations. This is especially true of earth-moon-earth operation. Needless to say, successful earth-moon-earth operation requires the utmost in performance of all elements of the system from high-power amplifiers, receive pre-amplifiers and antennas. Unfortunately, wide frequency separation between transmit and receive frequencies, necessitated by differing allocations, often leads to less-than-optimal equipment performance, especially in the case of antennas.

ADVANCED TECHNOLOGY PLANNING AND EXPERIMENTATION

15. An important purpose of the Reconciliation Act is facilitating the development of "new and innovative technologies" for the benefit of the public. The amateur-satellite service is in the forefront of just such technologies. New satellite and ground-based telecommunications systems being authorized by the FCC have benefited from the advances made in experiments developed for use in the amateur-satellite service. To cite one significant example, the LEO satellite systems now being authorized by the FCC use packet radio hardware and software technologies originally developed by the amateur radio community for use in the amateur-satellite service, particularly for the AMSAT MICROSATs and the University of Surrey's UOSATs. In fact, one of the applications recently received by the Commission in the so-called "Little LEO" proceeding propose a satellite based on the MICROSAT design developed by AMSAT volunteers and used in the construction of four satellites launched in January 1990. Later, this same design was embodied in a spacecraft, known as EYE-SAT, built by Interferometrics, Inc. of McLean, Virginia.

16. As an extension of this spinoff concept, the amateur satellite community is evolving standards for high speed digital data and digital video transmission using compression technologies that are ideally suited for small-satellite applications. In order to test and implement this type of technology, frequency allocations with adequate bandwidth are essential. As previously stated, the 2.4 GHz frequency band is the best suited frequency band for the downlink for this type of experimental digital communications. The communications transponders used would pair uplinks at 1260-1270 MHz with downlinks in the 2400-2410 MHz frequency band.

17. Amateur-satellite groups are also doing pioneering work in the development of high-efficiency, high-power amplifiers for this portion of the radio spectrum. Linear 2.4 GHz amplifiers with efficiencies as high as 40 percent have already been developed by the amateur community. AMSAT's Phase 3D spacecraft will carry solid-state amplifiers for the 2.4 GHz amateur-satellite band capable of in excess of 100 watts of RF power output and over 10 kilowatts of effective radiated power.

18. These technologies under development by amateur groups, when taken together and with an adequately wide 2.4 GHz amateur-satellite allocation, will provide powerful demonstrations of low-cost digital video and data transmission techniques. These technical approaches differ from direct broadcast technologies because they are bi- directional and will involve multiple widely scattered amateur stations. Both time-division and code-division multiple access techniques are under consideration.

19. In addition to experimentation with digital video and high speed packet data links, several amateurs have expressed an interest in investigating low-cost spread spectrum techniques. Spread spectrum communications experiments are important because they may lead to feasible methods of spectrum sharing by various commercial satellite and terrestrial services, applications currently under consideration by the FCC. In fact, hardware is presently being constructed for tests leading to employment of just such a spread spectrum technique in a future amateur satellite.

FREQUENCY-SHARING AND INTERFERENCE CONSIDERATIONS

20. We have already mentioned interference experienced in the amateur-satellite service as a result of high-powered devices such as radars and interference arising from amateur and non-amateur use of the 144-146 and 435-438 MHz bands. Some interference from radars is also present in the 1260-1270 MHz uplink band. The 2.4 GHz band presents a unique challenge in that ISM devices, principally microwave ovens, are present. Microwave ovens are particularly detrimental to amateurs because they are found in most homes, and most amateurs operate in residential areas. For this reason, amateur and amateur- satellite operation should be afforded a part of the band as far away from that occupied by ISM devices as possible. The Commission is reminded that, following a study done for the Voice of America, the U.S. sought an allocation at WARC-92 for broadcast-satellite service (sound) from 2310-2360 MHz - as far away, in that band, from the 2450 MHz ISM center frequency as possible. AMSAT wonders how close to 2450 MHz the majority of microwave ovens remain. Data provided by NTIA in its Preliminary Report seem to support the conclusion that applications involving reception of weak signals in residential areas is jeprodized by use of frequencies in close proximity to microwave ovens. It has been shown that experimental weak-signal amateur operation, such as earth-moon- earth and long-haul tropospheric communications, must have as clear a frequency as possible. This potentially valuable type of work is currently concentrated at 2300-2310 MHz, specifically near 2304 MHz. AMSAT supports a continued suitable allocation for this activity.

21. In addition to satellite and weak-signal communications, many amateur experimenters are interested in relatively short-range activities, such as amateur television and high speed data transmission. Some of that type of work is already being accomplished in the 2.4 GHz band. These kinds of activities generally require relatively large bandwidths and higher received signal levels than do satellite, long-haul tropospheric or earth- moon-earth communications and, therefore are somewhat more tolerant of having to share spectrum with other users. The general use of relatively narrow beam directive antennas, characteristic of this kind of amateur activity, also aids in such sharing. These wider-band, shorter-range activities are certain to increase in number in the future, and will need to be accommodated.

22. The amateur-satellite service presently utilizes and expects to significantly expand its use of the 2.4 GHz band. For various reasons, already discussed, this band is a prime area of the spectrum for amateur communication experiments and applications. Due primarily to the extremely high cost of geostationary satellites, no amateur spacecraft of that type has yet been launched and none is in serious development at the present time. Therefore, satellites in the amateur-satellite service are in lower or elliptical orbits that cover virtually the entire earth, albeit not all regions simultaneously. Consequently, the frequencies used by amateur satellites must be available worldwide. Thus, unlike terrestrial applications or those involving geostationary satellites, allocations of spectrum to the amateur-satellite service must be made consistently throughout the world, rather than on a national or regional basis. Therefore, any decisions with regard to allocations for the amateur- satellite service made in the United States must be

coordinated with other governments. Otherwise, the results are likely to prove useless for the purposes for which they are intended. A case in point is the 3400-3410 MHz amateur-satellite service allocation currently provided for in the ITU Table of Allocations. This segment is stated as being available, but in Regions 2 and 3 only. Since it is not available in Region 1, it has not yet been employed for amateur- satellite use, and is the only band between 21 MHz and 24 GHz that was not been considered for inclusion in the Phase 3D spacecraft now under construction. Since most amateur satellite work in this part of the spectrum requires the use of relatively high gain directive antennas, the opportunity for sharing with the right type of partner(s), presents itself. Current amateur satellite activity near 2400 MHz demonstrates that such operation can be carried out in the presence of microwave ovens. AMSAT believes, although we have no proof, that it can also take place if the band is shared with spread spectrum Part 15 devices.

RECOMMENDATIONS

24. In view of these considerations and the anticipated near-term future needs of the amateur and amateur-satellite services, AMSAT urges the Commission to take the following actions:

a. Establish an amateur and amateur-satellite allocation from 2400-2410 MHz on a Primary basis, with no additional sharing partners other than the existing ISM assignment and spread spectrum Part 15 devices.

b. Retain access, for the amateur service, to 2390-2400 MHz and, for the amateur and amateur-satellite services, to 2410-2450 MHz, both on a Secondary basis shared with what are, according to the Commission's determination and the considerations outlined in Paragraphs 4 and 20 through 22 above, the most compatible sharing partner(s). As discussed above, AMSAT suggests that, in the light of the need to protect the work going on at Arecibo and the proximity of ISM devices operating around 2450 MHz, the optimum use of this portion of the spectrum is for amateur radio shared with spread spectrum Part 15 devices. From the amateur standpoint, these also represent the best sharing partners. Thus, we suggest that 2390 - 2400 MHz be allocated to these devices on a shared basis with the amateur service.

c. Provide at least 1 to 2 MHz of spectrum below 2400 MHz, on a Primary basis, for the amateur service in order to accommodate weak-signal terrestrial and earth-moon-earth experimentation. This small window should be as far from the 2450 MHz ISM center frequency as possible, preferably near the presently used 2304 MHz frequency.

CONCLUSION

25. AMSAT believes that by implementing the foregoing recommendations, the Commission will be using these frequencies in the most optimum manner, as well as complying with the intent of the Reconciliation Act. At the same time, it will be insuring the continued health of the amateur-satellite service and providing it, and the amateur service, with the renewed confidence; including assurance to prospective manufacturers of equipment and components they need, to go forward with new innovative techniques in this portion of the spectrum.

RESPECTFULLY SUBMITTED,

Radio Amateur Satellite Corporation
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By_____
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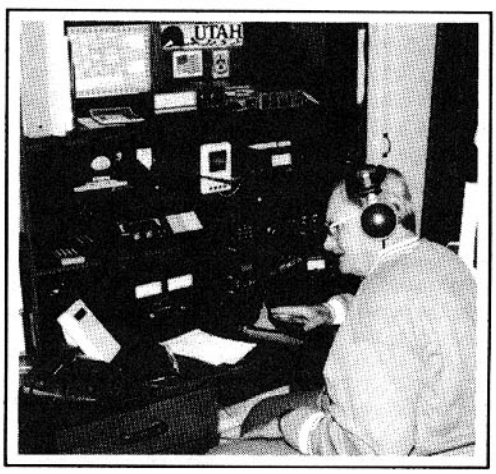

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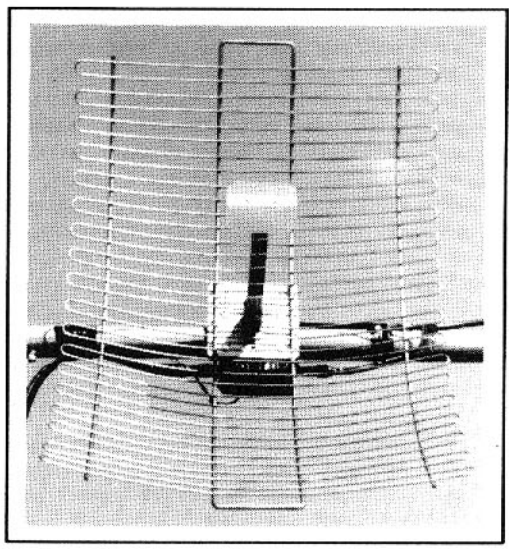

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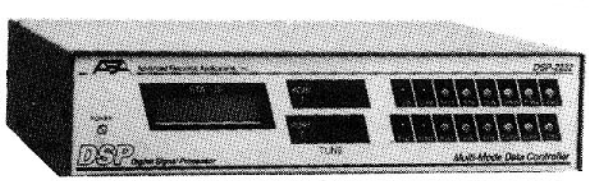

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